REPORT OF THE CHIEF OF THE BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, AGRICULTURAL RESEARCH ADMINISTRATION, 1944

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., September 15, 1944.

Dr. E. C. AUCHTER,
Agricultural Research Administrator.

DEAR DR. AUCHTER: I submit herewith a report of the work of the Bureau of Entomology and Plant Quarantine for the fiscal year ended June 30, 1944.

Sincerely yours,

P. N. ANNAND, *Chief.*

RESEARCH WHICH HAS FOR ITS OBJECTIVE more stable agricultural production was never more needed than it is today. A great part of the efforts of all the farmers on all available land can be frustrated by outbreaks of insect pests if they occur at critical times and places. No plans for victory in the war or for subsequent reconversion in this country and reconstruction abroad can be successful if they do not take into account the possibility of epidemics of insect-borne diseases and large-scale losses in yield or quality of growing crops or stored products resulting from the attacks of destructive insects. Research in the Bureau of Entomology and Plant Quarantine seeks to learn more about injurious insects—how to recognize them, their habits, and measures to control them at reasonable cost—and also how to make better use of beneficial insects.

Some of the information thus acquired is utilized directly in the Bureau's programs to suppress dangerous insects and to prevent their spread. Most of the results of research are made available as rapidly as possible. Many important contributions have been made, some of which are being employed to protect the health and comfort of civil and military populations and some to assist in stabilizing agricultural production by reducing losses and maintaining more consistent yields.

Measures for louse control developed by the Bureau and recommended to the Army and Navy were used to good purpose in stamping out a typhus epidemic in Naples, Italy, last winter, as recorded in accounts carried in periodicals of national circulation. As a result of this experience a high official in the War Department has stated that typhus fever has now become one of the easiest diseases of man to control.

Striking reductions in infestations by the Japanese beetle are following the continued distribution of the milky disease of the grubs. At the request of the War Department the distribution during the past

616016—45——1

year has been concentrated largely in essential grass or turf areas in military establishments, particularly on airplane landing fields.

The development of an improved grasshopper bait spreader and advancement in the application of insecticides from the air also furnish gratifying evidence of progress in insect control. Not so satisfactory has been the situation with respect to the pink bollworm on cotton. The spread of this insect to Louisiana, where a noncotton zone is in effect in Cameron Parish, and the discovery of infestations in three additional Gulf coast counties give cause for concern.

In this report will be found numerous references to investigations on the insecticide 2,2-bis(*p*-chlorophenyl)-1,1,1-trichloroethane, the common name of which is DDT. The total output of this material in this country at present is being devoted to the needs of the armed forces, with the exception of a small amount that is being used for experimental purposes. Although results now available indicate that it will be an important agricultural insecticide, it is necessary to learn more about its effectiveness against various injurious insects and the quantities and concentrations needed for their control. Additional information will have to be obtained with respect to its effect on plants and beneficial insects and what, if any, hazard to human beings and animals may be associated with its use.

FRUIT INSECT INVESTIGATIONS

CONTROL OF THE CODLING MOTH WITH DDT INDICATED

The new organic insecticide DDT gave remarkable control of the codling moth in preliminary field tests carried on at Vincennes, Ind., beginning late in July 1943. Three applications of 3 pounds of a 50-50 DDT-pyrophyllite mixture per 100 gallons without supplements completely stopped a heavy worm attack for the remainder of the season. Where the DDT-pyrophyllite mixture was used at only 1.5 pounds per 100 gallons, the fruit averaged only 31 worms per 100 apples as compared with about 100 worms per 100 apples following the lead arsenate program. In some field experiments the DDT permitted large increases in the population of European red mites, apparently by killing or repelling certain ladybird beetles that prey on the mites. Considerable defoliation occurred on trees of the Grimes variety sprayed with DDT, but this may have been caused by the abundant mites. No defoliation occurred on trees of the Winesap variety.

OTHER INSECTICIDES TESTED ON THE CODLING MOTH

At Yakima, Wash., the method of using xanthone for controlling the codling moth in the Northwest was improved to the point where 2 pounds to 100 gallons gave better results than 3 pounds of lead arsenate. For the third season this insecticide greatly reduced the population of the Pacific mite. Field tests with a dinitro-*o*-cresol spray to destroy hibernating codling moth larvae, made on a larger scale than previously, killed 86 to 94 percent of the larvae and reduced the subsequent infestation in fruit 25 to 50 percent.

Although phenothiazine has given a high degree of kill of the codling moth in the Northwest, no way has yet been developed to prevent its adverse effect on the color of red apples, and work with it has been largely discontinued for the present.

At Vincennes, Ind., the repeated evening spraying of apple trees with small quantities of nicotine sulfate solution poisoned many of the moths and reduced the number of injuries by 42 percent.

PARLATORIA CHINENSIS CONTROLLABLE

Laboratory and field tests at St. Louis, Mo., indicated again that effective commercial control of the introduced scale insect *Parlatoria chinensis* (Marl.) can be obtained with oil emulsions. An emulsion containing 3 percent of a paraffin-base oil with a viscosity of 100 Saybolt seconds or higher or 4 percent of a similar naphthene-base oil should be applied during the late-dormant or delayed-dormant period, and an emulsion containing 2 percent of an 80-second or higher paraffin-base oil during the summer at times when most of the scales present are in the immature stages.

A continuation of the survey to determine the distribution of this scale insect has revealed for the first time a number of infestations in St. Louis County. The outermost infestation was about 5 miles from the St. Louis city limits. Several shipments of plants from infested properties to other States were followed up without bringing to light any new infestations.

ADVANCES IN CONTROL OF THE PLUM CURCULIO ON PEACH

Two applications of ground sprays consisting of dichloroethyl ether or dichloroethyl formal at Fort Valley, Ga., proved as effective against the plum curculio as the regular schedule of lead arsenate sprays.

An improved curculio-jarring sheet which holds the curculios in a bag in the center, developed at the Fort Valley laboratory, caught an average of 2.5 beetles per tree as compared with 1.3 beetles per tree caught with the old sheets.

NEW INFORMATION ON ORIENTAL FRUIT MOTH PARASITES

A big increase in the production of *Macrocentrus ancylivorus* Roh., the most important parasite of the oriental fruit moth, has resulted from rearing the parasites on the potato tuber worm. Use of this new host was made possible by the discovery of the tuber worm near Moorestown, N. J., where it had not formerly been believed to be present. This parasite was found to overwinter abundantly in strawberry leaf roller larvae infesting wild blackberries and related plants which occur in large numbers in the vicinity of peach orchards in southern New Jersey. This finding opens up the possibility of effective parasite colonization late in the season, and indicates that cage breeding of parasites on the strawberry leaf roller might be more successful with some of these newly found plant hosts than with the cultivated strawberry previously used.

CULTURAL METHODS CONTROL SHUCKWORMS ON PECAN

Further experiments at the Albany, Ga., laboratory in cultural control of the hickory shuckworm by destruction of the larvae in infested nut drops through the use of a disk tiller substantiated the favorable results obtained during the three previous seasons. For the

Schley and Stuart varieties the percentage of nuts infested was reduced about one-half, and the treatment more than doubled the yield of nuts.

CHERRY FRUITFLIES CONFORM TO LIFE ZONES

The cherry fruitflies, chiefly *Rhagoletis cingulata* (Loew) and to a lesser extent *R. fausta* (O. S.), have been found on the west coast in the Transition and Canadian Life Zones from the Sequoia National Forest north, wherever the preferred wild host, *Prunus emarginata* (Dougl.) Walpers, occurs. South of that point this host has not fruited for several years. In California these life zones occur at elevations mostly above 5,000 feet, where cultivated cherries are not grown. In Oregon cultivated cherries are grown in the Transition Zone, and in parts of that State they are extensively infested. This study was made by the Oregon Experiment Station in cooperation with the Bureau and the California Department of Agriculture.

GASTIGHT TENTS GIVE IMPROVED CONTROL OF CALIFORNIA RED SCALE

In studies of the California red scale carried on at Whittier, Calif., considerable work was done in the field with tent fabrics differing in gas-retention properties. Fabrics treated with certain plastic products were found to retain three to four times as much gas to the end of a 45-minute exposure period as the standard fumigation tents now in use. Correlated with the gas retention is a higher mortality of scales, or the possibility of an equal kill with lower initial dosages. With the blowers and gastight tents it has been possible to duplicate concentrations in successive exposures on different trees, and from night to night. By using scales of a known age and strain, it has also been possible to duplicate very closely the mortality obtained.

MILKY DISEASE CONTROLS JAPANESE BEETLE GRUBS

The milky disease of the Japanese beetle has continued to cause conspicuous reductions in infestation of the grubs wherever it has become well established in the soil. In the Mall section of Washington, D. C., for instance, where populations as high as 50 grubs per square foot of turf were recorded in 1941, and which received an intensive milky disease treatment, practically no grubs or beetles were in evidence during the spring and summer of 1944. The colonization of the organisms causing this disease is being continued.

At the request of the Office of Chief of Engineers, War Department, surveys of Japanese beetle grub infestation in maintained grass or essential turf areas were undertaken at military installations in the First, Second, and Third Service Commands during the dormant season of 1943–44. A program of milky disease treatment was started in March 1944 at installations where conditions called for treatment.

DDT EFFECTIVE AGAINST JAPANESE BEETLES

In field tests against adult Japanese beetles during the summer of 1943, ¼ pound of DDT per 100 gallons afforded the same protection to peaches as a single application of the recommended derris-rosin residue emulsion spray, protecting both fruit and foliage for 2 weeks.

A single application of a spray containing 1 pound of DDT per 100 gallons gave complete protection to the fruit and foliage throughout the entire beetle feeding season of more than 6 weeks. The spray left no visible residue on the fruit or foliage and caused no injury when used at a concentration of 1 pound in 100 gallons.

DDT has also been found effective at very low concentrations against the grubs of the Japanese beetle in the soil. In a number of soil types DDT, when freshly applied at rates of 5 to 27 pounds per acre, was as effective as lead arsenate at the rate of 500 pounds per acre. Studies in the greenhouse indicated that relatively large quantities of DDT could be applied to the soil without detrimental effect on certain crops, but that others, such as beans, spinach, and tomatoes, seem to be unfavorably affected with applications of 25 pounds of DDT per acre.

PEAR PSYLLA SUPPRESSION CONTINUES

Further progress has been made toward the suppression of the pear psylla in the Pacific Northwest. The number of infested properties found has continued to decline, 140 being found in 1943 as compared with more than 1,200 in 1941. Only minor extensions of the infested area have been brought to light. In the spring and early summer of 1944 one light infestation was found in lower Yakima County and several in Benton County, Wash. Three infestations were also found in Umatilla County, Oreg., within a few miles of the Washington State line.

The sticky-board trap, mentioned in last year's report, is proving a valuable aid in determining the distribution of the pear psylla. The board is about 6 by 10 inches, and is covered on both sides with a sticky tree-banding material. Yellow boards have captured more psyllas than any other color tested. The trap boards have revealed light infestations not found by the most careful visual scouting. One hundred thousand are being placed this summer at various points in the Northwest and elsewhere. Their use will give a much more complete picture of the infestation than has been possible thus far.

The spray program continues to reduce the psylla infestation. A special study of the effects of the program was made in Spokane County, where intensive spraying has been carried on since 1940. In 1943 spraying was discontinued in that county, except on properties that had been found infested in 1942 or 1943. Thorough scouting in the entire county resulted in the finding of only 70 infested properties, as compared with 889 in 1940 and 466 in 1941. Some spraying was done in British Columbia in 1943 and 1944 to protect the results obtained south of the border. In some areas cooperating growers assisted greatly in the program by applying much of the spray material themselves.

The removal of abandoned pear trees by the Washington State Department of Agriculture and the grubbing and treatment of pear regrowth by both agencies have eliminated many scattered properties from the spray program, and in some areas the time required for a given coverage has been cut by at least one-half. Considerable quantities of ammonium sulfamate are being used in the treatment of sprouting stumps and regrowth.

PROGRESS MADE TOWARD ERADICATION OF HALL SCALE

Marked progress is being made toward the eradication of the Hall scale from the area around Chico, Calif. Inspections have been made at several localities to which shipments from the United States Plant Introduction Garden were sent before fumigation was adopted, but no new infestations have been found. Further surveys of this kind are being made.

Spraying with oil, although not giving perfect kill, has reduced the infestation to a low point, thus minimizing the danger of spread. Test fumigations with hydrocyanic acid gas under tents have given complete kill of all scales present, and final eradication by means of fumigation seems entirely feasible.

FRUITFLY INVESTIGATIONS

In Mexico preliminary studies with DDT in dusts and oil preparations have shown promise in preventing fruit infestation.

In Mexico also sublethal quantities of tartar emetic ingested by the Mexican fruitfly were shown to inhibit egg development.

Infestation tests in Hawaii on tomato varieties developed by the agricultural experiment station there have shown three hybrids that are highly resistant to the melon fly.

At the Canal Zone station studies in addition to those on fruitflies are under way to determine the resistance to termites of different cable-insulating materials.

INVESTIGATIONS OF INSECTS AFFECTING FOREST AND SHADE TREES

ENGELMANN SPRUCE BEETLE OUTBREAK IN COLORADO

An extensive outbreak of the Engelmann spruce beetle has developed in Colorado during the last 2 years. The infestation was first reported on the White River National Forest in 1942, and it is now known to be present on the Grand Mesa, Routt, Uncompahgre, and Gunnison National Forests. An estimated 150 million board feet of Engelmann spruce has been killed on the White River and the Grand Mesa National Forests. The Forest Service is attempting to salvage as much of this dead timber as possible. About half of the timber resources of Colorado and Wyoming, or approximately 20 billion board feet, consists of Engelmann spruce. Much of this timber is mature or overmature, and conditions are apparently favorable for continued widespread destruction by this beetle. On one small area on the White River National Forest where a recent survey was made, it was found that 35 million board feet, or 77.5 percent of the stand, on 2,227 acres, had been killed since February 1942. Since very little is known about this insect, it is impossible to make recommendations for control at the present time. A study is to be made of its life history as a basis for control work. Infested trees are difficult to detect because the foliage does not change color as does that of pines infested with bark beetles.

PINE BARK BEETLE SITUATION CONTINUES FAVORABLE

Bark beetles that attack the various species of western pines caused comparatively little damage during the past year. There were a few

localized areas where the insects appeared to be on the increase, and it is possible that the low point in the infestation cycle has been passed.

Assistance was given Federal and private agencies in the control of the western pine beetle through application of sanitation-salvage logging, and a close check was maintained of results on earlier projects in California. Other agencies are adopting this method of logging in stands of ponderosa pine where the beetle hazard is high. Beetle-control logging projects have been begun on the Warm Springs Indian Reservation and the Fremont National Forest in Oregon, and on the Yakima Indian Reservation and Snoqualmie National Forest in Washington. Other areas will be included when the supply of equipment and manpower permits lighter cuts over larger areas.

Two studies recently completed explain why certain trees and areas are more susceptible than others to pine beetle attack. One analysis demonstrates a relationship between ground cover and insect attack, and the other shows effects of root injury and soils on tree health. Both point to the importance of root development, soil, and competition. Federal and private agencies interested in these studies have given valuable assistance and are already putting to use some of the results.

SPRUCE BUDWORM OUTBREAKS CAUSE CONCERN

An extensive outbreak of the spruce budworm in the central Rocky Mountain region has killed or weakened tremendous quantities of Douglas fir, alpine fir, white fir, blue spruce, Engelmann spruce, and ponderosa pine. Much of the timber in this area is of value for watershed protection and recreational purposes. Previous attempts to control this insect by spraying with lead arsenate around camp grounds and other special use areas have been only partially successful. A series of spraying experiments conducted in the spring of 1944 in cooperation with the National Park Service and the Forest Service indicate that control can be obtained by the application of DDT at the rate of 1 pound per 100 gallons of water.

A widespread outbreak of the budworm has been in progress in parts of Ontario and Quebec for several years. The extreme destructiveness of this outbreak, together with the present critical shortage of pulpwood, has caused timber owners in the New England and Great Lakes States to become very much concerned about the possibility of similar losses in the United States. Plans have been made for an intensive study giving special attention to development of forest-management practices that will reduce the likelihood of an outbreak or aid in the salvage of infested timber.

IMPROVEMENTS IN AERIAL APPLICATION OF INSECTICIDES

The most important development in work being conducted in cooperation with the Division of Gypsy and Brown-Tail Moths Control has been the spectacular control of the gypsy moth obtained through the aerial application of DDT. A 20-acre tract of infested woodland located in Jefferson, Pa., was treated on May 3, 1944, with a concentrated spray mixture at the rate of 5 pounds of DDT per acre. The spray, released through a specially constructed distributor, settled through the forest as a fine mist, which gave good coverage of exposed surfaces of trees, undergrowth, and the forest floor. Foliage was just

beginning to appear, and no eggs of the gypsy moth had hatched. After the spray had dried, a fine crystalline deposit of DDT remained on all exposed parts of the forest. Observations indicated that the eggs hatched but that the small caterpillars were killed when they started crawling and came in contact with the DDT. No living larvae were found in the treated area. Furthermore, all black flies were eliminated from the area for at least a month after treatment.

The success of this experiment offers promise for extending the period over which infested areas may be treated. The residual effect of DDT may permit the beginning of spraying a month or more before gypsy moth eggs hatch. A study of small infested areas treated with DDT after foliage appeared and caterpillars were in different stages of development indicated that this insecticide also kills the larger larvae of the gypsy moth.

The same aerial equipment was used for applying a concentrated cryolite suspension to infested woodland. A fine, uniform deposit of cryolite, which adhered well after considerable rainfall, was obtained. The final results of this treatment cannot be accurately determined until late summer when egg deposition is over.

WAR FABRICS PROTECTED FROM TERMITE DAMAGE

Owing to the rapid deterioration of untreated fabrics in the tropical theaters of war as the result of attack by termites and micro-organisms, tests were made during 1943, both in the laboratory and in the field, to determine which chemical treatments offered most resistance to damage by these destructive agents. Such tests were conducted in cooperation with the War Department and with several other agricultural agencies. About 900 samples of fabrics, consisting of such materials as balloon cloth, canvas, twill, cotton Osnaburg, and light- and heavy-weight duck, were tested. A number of chemicals or mixtures were found to protect the fabrics from damage by termites.

PLANTATION INSECTS MAY INFLUENCE POSTWAR PLANTING PROGRAM

Studies of insects affecting young trees planted in the reforestation program under way in the Lake States have shown that much can be done to reduce the probability of serious damage by insects by using certain mixtures of tree species in all forest plantations. In many cases insects have caused extensive damage in plantations that were established in blocks of single species. Where mixed plantings were made or the trees were planted among natural stands of hardwoods, there has usually been less injury.

One of the most important plantation insects in the Lake States is the spittle bug *Aphrophora saratogensis* (Fitch), heretofore unknown as a pest of pine. It is widely distributed, and many thousands of acres of plantations and young natural growth of jack pine and red pine show serious damage and in some cases considerable tree mortality from it. The life history and habits of the insect have been studied, and in the spring of 1944 arrangements were completed for a cooperative study with the Bureau of Plant Industry, Soils, and Agricultural Engineering and Wisconsin State officials to determine the possibility of an interrelationship with some disease organism. The white pine weevil, the pine sawflies, the pine chafer, and the pine tortoise scale are also important pests in the extensive pine plantations

throughout the Lake States. The information gained from 3 years' study on permanent sample plots indicates that much of the damage by these insects can be prevented by good silvicultural practices.

CEREAL AND FORAGE INSECT INVESTIGATIONS

DDT SHOWS PROMISE AGAINST VARIOUS CEREAL INSECTS

Preliminary experiments indicate DDT to be a very promising insecticide for use against the European corn borer, the white-fringed beetle attacking a variety of staple crops, the chinch bug as a pest of corn, the velvetbean caterpillar, grasshoppers, the vetch bruchid, and insects attacking stored grains and packaged cereal products.

PROGRESS IN DEVELOPMENT OF INSECT-RESISTANT STAPLE CROPS

Intensive experiments to utilize varietal resistance to infestation by insects attacking a number of staple crops are being continued in cooperation with Department and State experiment station agronomists, with promising results.

Big Club 43, a variety of wheat being increased for release in 1944 to California wheat growers, showed high resistance to the hessian fly in two localities. This variety is also resistant to stem rust, bunt, and root rot. Thirteen promising advanced hybrids were included in eight adaptability test nurseries in Kansas. In Indiana high resistance to the hessian fly, mosaic, bunt, loose smut, leaf rust, and stem rust is being combined in advanced lines with good quality and yield. One of these fly-resistant hybrids outranked the standard varieties Fairfield and Trumbull in yield tests. Out of 201 varieties and hybrid selections tested in the greenhouse at the Beltsville Research Center, 16 showed high resistance to the fly.

In observations at Manhattan, Kans., 20 varieties of wheat and 9 of barley out of about 200 spring varieties of these crops tested were lightly infested by the chinch bug while other varieties were severely stunted.

Corn varieties tested in Illinois showed two types of resistance to the earworm—reduction in damage to infested ears and inability of the larvae to become established. Eleven families and three individual lines of corn were rated as highly resistant. Among hundreds of lines examined in test plots in Mississippi, several showed low infestation by the earworm and the rice weevil. Length and tightness of husk apparently were not the only factors responsible.

Several alfalfa plants showing marked resistance to the pea aphid, a serious pest of alfalfa, were selected from many thousands of seedlings tested at Manhattan, Kans., and passed on to the plant breeder for use in developing aphid-resistant strains of agronomic worth. Experiments in cooperation with the California Agricultural Experiment Station indicated that a synthetic variety having high resistance to aphids and increased vigor of growth might result from systematic crossing of two separate aphid-resistant families.

Progress has been made in methods of segregating the European corn borer and intensifying the resistance of field and sweet corn to this insect, and in utilizing this resistance on a commercial scale.

616016—45——2

In the exploratory tests of inbred lines and open-pollinated varieties, 5 out of about 350 sweet-corn entries were promising as borer-resistant breeding material, and no additional resistant field lines were found among approximately 900 field-corn entries tested. It was decided that in determining the ability of a variety to resist borer attack the following factors should be considered: Type and rate of plant growth, pollen accumulations that serve temporarily as food for the larvae on different parts of the plants, and comparative abundance of the sucking bug *Orius insidiosus* Say, that preys on the eggs and larvae of the corn borer.

In testing over 4,000 varieties of sugarcane for resistance to the sugarcane borer, 2 were found promising for use as resistant parental material in breeding work. Forty-six classed as resistant in previous tests maintained this status in the 1943 trials. In the investigation of commercial varieties it was found that susceptible varieties produced 245 pounds less sugar per acre when heavily infested than when lightly infested, but that none of the resistant varieties produced less sugar per acre when heavily infested.

DEVELOPMENTS IN CORN EARWORM CONTROL

Tests of mineral-oil emulsions, with and without pyrethrins, atomized on the ear silks showed that there is a possibility of controlling the earworm by this method at less cost than when the oil-injection method is used. This might make their application to canning corn practicable. In preliminary tests an infusion of a bacterial disease of the earworm sprayed on the silks or injected into them did not interfere with pollination but did result in a fair degree of control. This method of control may have possibilities if a cheap method of culturing the bacterium in quantity can be devised.

WINTER GRAZING CONTROLS PEA APHID ON ALFALFA

Grazing of alfalfa in the Antelope Valley of California until March 1 prevented the development of severe early-spring pea aphid infestations except in some fields that were reinfested by migrants from ungrazed fields. In previous years late-winter or early-spring grazing of alfalfa in western Nevada satisfactorily disposed of spring aphid infestations.

GRASSHOPPER POPULATIONS AT A LOW EBB

Owing to the generally cold, wet springs of 1943 and 1944 and unfavorable conditions for fall egg laying in some areas, grasshopper infestations in the Great Plains and Rocky Mountain States have been considerably reduced and more local in character. Conditions were more favorable in Arizona and California, however, with attendant high populations in some localities.

LATE-SEASON BAITING OF ADULT GRASSHOPPERS A PROMISING LOCAL PREVENTIVE MEASURE

Large-scale poisoning of adult grasshoppers when they are congregated on their favorite egg-laying grounds late in the season was tried during 1943 in several California and Montana localities. The results indicate that this may prove to be an economical measure for prevent-

ing local infestations and may eliminate the need for more extensive and costly control operations in subsequent seasons.

REPLACEMENT OF BROADLEAFED WEEDS BY GRASSES ON ROADSIDES AND FIELD MARGINS GREATLY REDUCES GRASSHOPPER EGG LAYING

Observations during 1943 confirmed those of previous years that the numbers of grasshoppers and their eggs are greatly reduced in roadsides and field margins, important grasshopper breeding places, when broadleafed weeds are replaced by nearly solid stands of grass.

ADDITIONAL MORMON CRICKET OUTBREAK CENTERS LOCATED

In connection with field ecological studies new centers were located where Mormon crickets persist during periods of general scarcity, six of them in Nevada and one in Wyoming. The location of such areas and the control of this pest therein may result in prevention of general outbreaks at comparatively low cost. The studies indicated that hatching of crickets in such areas is delayed by continued cold until so late in the spring that there is little likelihood the crickets will be killed by adverse weather subsequent to hatching, as they often are in localities in which climatic conditions are less favorable.

NEMATODES PARASITIC ON WHITE-FRINGED BEETLE

An intensive investigation of certain nematodes known to be parasitic on the white-fringed beetle, a serious exotic pest of staple crops in the Gulf States, has shown these nematodes to be common both inside and outside the infested areas but apparently not a dominant factor in keeping down the numbers of the beetle.

INSECTS IMPORTANT FACTORS IN ALFALFA SEED PRODUCTION

Although *Lygus* spp. and other sucking bugs that attack alfalfa seed and hay crops in Arizona and Utah were much less abundant in 1943 than in the peak year 1941, their injury to the seed crop in Arizona was estimated to be over $500,000. Observations in that State indicated that suitable cultural practices provided considerable protection when applied on individual farms as well as throughout a community. As much as 90 percent of the alfalfa blossoms of plants attacked by sucking bugs may fail to set seed. This failure is apparently due largely to the scarcity of the wild and domestic bees necessary to effect pollination. Studies are now in progress in cooperation with the Utah Agricultural Experiment Station on the utilization of bees to increase pollination.

NEW DEVELOPMENTS IN CONTROL OF INSECTS ATTACKING STORED GRAINS AND MILLED CEREALS

Six organic compounds showed considerable promise in preliminary tests as substitutes for the standard grain fumigants, the supplies of which are more or less limited by war conditions. Several materials, including white lead paint, whitewash, and a solution of nicotine sulfate, were highly effective in preventing the cadelle and the lesser grain borer from burrowing and persisting in the woodwork of wooden grain bins and infesting grain newly stored in these bins. Several organic and inorganic dusts, including DDT and magnesium oxide,

when added to wheat in extremely small percentages, were found to protect it from insect attack. One or more of these dusts may be found useful for preventing insect infestation of stored grain and other seeds for planting, if not for food.

Laboratory studies on the relation of temperature and moisture content of grain to the development and control of insect infestation therein showed that bran beetles do not lay eggs at 65° F. or below and that little insect activity occurs until the grain temperature exceeds 70° F. Bran and flour beetles bred in grain of almost any moisture content in which plenty of grain dust or broken kernels was present, but weevils did not breed in grain of less than 9-percent moisture content and bred only to a limited degree in grain of less than 11-percent moisture.

Serious injury to germination of wheat from normal dosages of grain fumigants occurred only when the moisture content was 14 percent or more. Baking tests in cooperation with the Kansas Agricultural Experiment Station indicated that loss of viability of wheat caused by fumigants apparently did not affect the baking quality of flour made therefrom, but that retention of fumigants in nonaerated wheat appeared to affect baking quality adversely.

Observations on stored soybeans indicated that insect infestation was of minor importance during the first year of storage.

OCCURRENCE AND CONTROL OF THE EUROPEAN CORN BORER INCREASING IN IMPORTANCE

The general level of corn borer abundance in 1943 was the highest on record, the loss of field corn from this insect amounting to over $28,000,000 and of sweet corn over $5,500,000, and the infested area was extended half way across Iowa and Missouri and clear across central Kentucky. Early sweet corn from central Illinois to the Atlantic coast north of the Ohio River was heavily infested, and most of it was a complete loss owing to borer damage.

Commercial-scale trials resulted in gross returns of $480 to $600 per acre from spraying and $54 to $196 per acre from dusting early-market sweet corn with ground derris, as compared with practically total losses where no treatment was applied. A preliminary test of insecticide application by airplane in 1943 gave promising results, and this method is receiving further trial in 1944. Two out of 247 new insecticidal compounds used in laboratory tests gave favorable results and are being given field tests.

Thirty-two parasite releases, involving 39,418 parasites and 3 species, were made in 10 States during 1943. In cooperation with several State experiment stations this work has been much expanded. A total of 457,000 corn borer larvae were collected in the fall of 1943, from which it is expected that at least 450,000 parasites will be obtained for liberation in 1944. Parasitization of larvae collected from the field in the fall of 1942 ranged from 16 percent in a few Connecticut fields to 69 percent in a few New Jersey localities.

ANNUAL LOSSES CAUSED BY SUGARCANE BORER

Surveys have shown that the sugarcane borer causes an annual loss in cane sugar production amounting to over $6,000,000. This insect reduced the 1943 yield in Louisiana alone by more than 200,000,000 pounds of sugar.

In commercial-scale dusting of cane for control of first-generation borers, applications of cryolite by airplane and ground equipment were about equally effective. Both gave a high degree of control, which in some instances amounted to as much as 50 percent reduction in numbers of borers present at harvesttime. In general, natural cryolite gave as good results as synthetic cryolite. Dilutions of these materials gave poorer control than the full-strength dusts.

The use of medium and heavily infested cane for seed resulted in estimated reductions in yield of 2.5 and 3.3 tons, respectively, of millable cane per acre, as compared with plantings of uninfested seed cane.

WEST INDIAN SUGARCANE MITE SURVIVES ERADICATION EFFORT

Although the eradication of the West Indian sugarcane mite attempted in 1941 appeared last year to have been successful, the mite was found to be again well established in two locations at Canal Point, Fla.

TRUCK CROP AND GARDEN INSECT INVESTIGATIONS

The control of insects that attack vegetables or transmit diseases to these crops has assumed an increasingly important role in the wartime food-production program. In addition to increased commercial plantings of such crops as beans, peas, potatoes, and tomatoes, the expansion of the Victory Garden campaign has created a further demand for information on insect control. Since some of the insecticides, such as pyrethrum and rotenone, are available only in limited quantities, it has been necessary to husband these supplies and to develop substitute materials or other control methods. A special effort has been made to disseminate information regarding insect control through the timely publication of bulletins and mimeographed material, as well as through the radio and the press and by personal contacts of Department workers with those interested in this information.

Special emergency surveys of insects and control requirements have been conducted, in cooperation with State workers, industry, and other agencies, in an effort to insure the distribution of insecticides to localities or districts where they are most needed.

ENCOURAGING RESULTS OBTAINED WITH NEW INSECTICIDES

In cooperation with commercial and State agencies a large number of new materials and combinations of materials have been tested for their insecticidal value. Among these materials the new synthetic organic chemical DDT was very effective, in preliminary field tests, against the following insects: Potato leafhopper, imported cabbage worm, cabbage looper, diamondback moth, cabbage webworm, pea aphid, Colorado potato beetle, flea beetles on potatoes, *Lygus* plant bugs, and the tomato fruitworm. Encouraging but not outstanding results were achieved with this material against the following insects: Pea weevil, onion thrips, gladiolus thrips, bean leaf beetle, stinkbugs of various species, and the beet leafhopper. Unsatisfactory or indifferent results were obtained against the Mexican bean beetle, the tobacco hornworm, the turnip aphid, and red spiders.

In tests directed against cabbage caterpillars, some insecticidal value justifying further tests was shown for yam bean flour, various nicotine combinations, a soap-water spray, scorodite, 2-chlorofluorene,

sodium fluosilicate, barium fluosilicate, potassium fluosilicate, and a low rotenone-containing product from the plant *Derris malaccensis* (Benth.) Prain. The fluorine compounds had a tendency to cause injury to cabbage, which limits their use as substitutes for the more desirable insecticides containing rotenone and pyrethrum.

In combating the pea aphid in 1943, dusts containing nicotine sulfate or rotenone combined with either nicotine or an organic thiocyanate proved less effective than dusts containing rotenone as the only active agent. Against the tomato fruitworm basic copper arsenate gave results superior to those obtained with calcium arsenate or cryolite, although DDT was the most effective insecticide tested against this important and widespread pest. In sprays for the Mexican bean beetle and the Colorado potato bettle good results were obtained with basic copper arsenate and micronized phenothiazine. Tests were made in Ohio to determine the relative efficiency against the Mexican bean beetle of two types of rotenone-containing dusts—ground derris or cube roots mixed with a diluent and impregnated dusts formed by depositing rotenone on the particles of the diluent. No differences in the results obtained could be detected, but since the dust mixtures are more easily prepared and less expensive than the impregnated materials, they would appear to be preferable for general use.

The new soil insecticide dichloropropane-dichloropropylene (DD) has given promising results against wireworms in southern California and in Washington, and has also proved of value in preliminary tests against larvae of the green June beetle infesting tobacco plant beds.

PROGRESS MADE IN ESTABLISHING RELATION BETWEEN INSECTICIDE DOSAGE AND INSECT CONTROL

As an aid in the conservation of insecticides, studies have been made on the most effective strengths and rates of application on several of the more important insects affecting vegetable crops. In field experiments directed against the pea aphid it was found that with dust mixtures containing from 0.25 to 1.5 percent of rotenone the quantity of rotenone applied per acre rather than the strength of the mixture governed the percentage of control. This relationship, however, did not prevail when the dust mixture was of lower rotenone content. For example, 60 pounds of a dust mixture containing 0.25 percent of rotenone gave approximately the same degree of control as 20 pounds of a dust containing 0.75 percent of rotenone; but 60 pounds of a 0.125 percent rotenone mixture was not so effective as 20 pounds of a mixture containing 0.375 percent of rotenone. The results demonstrated that when the recommended dosage of 0.33 pound of rotenone per acre was halved an appreciable reduction in control occurred. Moreover, a dosage one-fourth of that recommended was sometimes effective under favorable conditions for control, but the 0.33-pound dosage was required under unfavorable conditions.

MECHANICAL METHODS AID IN THE CONTROL OF INSECTS

In in experimental area in Tennessee traps and poison feeders baited with amyl salicylate reduced hornworm infestations by approximately 50 percent. However, the same methods tested in the flue-cured tobacco growing districts of North and South Carolina were less effective.

In Louisiana the use of vine-cutting machines combined with disking and plowing after harvest removed the crop remnants that serve as a winter food supply for the sweetpotato weevil in infested fields. The use of vine cutters prior to harvest facilitated the harvesting of the crop and the subsequent burying of crop remnants.

COMMODITY CREDIT CORPORATION ASSISTED IN PROTECTION OF LEND-LEASE TOBACCO

Throughout the year the Bureau's workers on stored-tobacco insects aided the Commodity Credit Corporation in protecting stocks of leaf tobacco purchased by the Government for lend-lease purposes. Surveys were conducted to find suitable warehouses, warehouses were inspected, a system of obtaining and recording infestation of tobacco with the cigarette beetle and the tobacco moth in each warehouse was developed, and recommendations were made as to control measures.

COTTON INSECT INVESTIGATIONS

Despite serious problems in manufacture and transportation due to the war, sufficient supplies of arsenical insecticides, sulfur, and cryolite were maintained and, although rotenone was not available for cotton and the nicotine supply was limited, essential insecticides were available for protection of the 1943 cotton crop. Through the cooperation of State and Federal agencies, growers, and many others, 25,741 examinations of cotton fields were made to determine current insect conditions and the local need for insecticides. This information will be of permanent value in determining the need for control and the time to apply insecticides.

Emphasis was given to research that aided the war effort by conservation of materials and manpower.

BOLL WEEVIL

The average reduction in cotton yield caused by the boll weevil in 1943 was estimated at 6.1 percent, as compared with 8 percent in 1942. In plots dusted with calcium arsenate at Tallulah, La., the average increase in yield over undusted plots was 278 pounds of seed cotton per acre, or 13.8 percent, as compared with the 24-year average of 309 pounds, or 22.2 percent.

Investigations were continued to determine how increases in cotton yields could best be attained from the use of reduced amounts of critical materials. Tests on high-yielding Louisiana soils confirmed previous findings to the effect that the recommended poundage per acre of calcium arsenate could not be materially reduced without sacrificing part of the potential gains, and that the largest increase in yield per pound of calcium arsenate resulted from delaying the first application until 20 to 25 percent of the squares were punctured. Over a 4-year period 5 applications beginning with square infestations of approximately 25 percent gave as large gains as 7 applications starting with infestations of 8 to 15 percent. Experiments have also been conducted during the last 5 years comparing control of weevil infestations that required 6 applications for complete protection of squares and bolls beginning before weevil migration, when 25 percent of the squares were infested, with only 3 late applications beginning after weevil migration had started. The former gave an average increase of 288

pounds of seed cotton per acre, or 48 pounds per application, and the latter a gain of 210 pounds per acre, or 70 pounds per application. However, on the lighter soils where cotton does not fruit so late in the season, control of the early weevil damage is more important.

Each year tests are conducted with various materials in the hope of finding an insecticide better than calcium arsenate for boll weevil control. Sodium fluosilicate, one of the most promising insecticides tested, prevented the proper development of the fiber and resulted in significant reduction in yield in one variety of cotton, though not in others. Barium fluosilicate, cryolite, DDT, and other materials tested were all inferior to calcium arsenate.

In tests to obtain additional information on mopping entire fields with molasses-calcium arsenate, 55 fields containing 276 acres were mopped at 6 localities in South Carolina, Georgia, Mississippi, Louisiana, and Texas. Half of the mopped area in 19 fields at 4 localities was also dusted with calcium arsenate when needed. The average gain for all 55 mopped fields was 83 pounds of seed cotton per acre; for the 19 most heavily infested fields, 142 pounds from mopping and 290 pounds from mopping and dusting. The gains from mopping were not significant at any locality, while dusting gave significant gains at 3 localities.

CHEMICAL DEFOLIATION FOR CONTROLLING COTTON INSECTS

Tests of chemical defoliation of cotton indicated that this treatment controls insects, improves the grade of fiber, increases the efficiency of mechanical cotton harvesting, and reduces the labor required for hand picking. In experiments in Mississippi, Texas, and Arizona dusting with 10 to 20 pounds per acre of calcium cyanamide, a commercial nitrogenous fertilizer, caused complete defoliation within a few days when moisture was abundant and the plants were succulent, but poor defoliation of water-stressed plants. Defoliation causes the small bolls and squares to shed and the mature bolls to open promptly and uniformly without a reduction in staple strength. This checks boll weevil breeding, prevents staining of lint by aphids or leafworms, permits all the crop to be picked at one time by hand or mechanical harvesters, reduces the trash, and improves the grade of lint.

COTTON APHIDS

The addition of nicotine to calcium arsenate to prevent the build-up of aphids increased the yields of seed cotton in 1943 by 137 to 435 pounds per acre in Mississippi, by 120 to 446 pounds in Louisiana, and by 0 to 132 pounds in Texas. The average gain in yield of seed cotton in 78 experiments at Tallulah, La., during 1939–43 was 128 pounds per acre when calcium arsenate dust was used against boll weevils and 393 pounds when calcium arsenate plus nicotine was used against both boll weevils and aphids. In other words, there was an increase in yield of 265 pounds when nicotine was added. In general, nicotine sulfate, free nicotine, and several fixed nicotines were about equally effective per pound of actual nicotine. Satisfactory aphid control was obtained in commercial dusting with airplanes or ground machinery at any time of day or night when atmospheric conditions were favorable for the dust to settle. None of the synthetic materials tested, including

DDT, thiocyanates, phenothioxin, and dinitro-*o*-cyclohexylphenol, have shown much promise.

The damage per aphid was found to be greater under dry than under moist conditions. In rainy years cotton on fertile Delta soils will tolerate a population of approximately 60 aphids per square inch of leaf surface before defoliation, whereas under the dry conditions of 1943 half this population caused premature leaf shed. In the drier areas of the West and on the soils with low water-holding capacity in the Southeast, cotton was defoliated by much lighter populations than in the Delta.

PINK BOLLWORM

During the last 2 years weather favorable for survival of hibernating bollworm larvae has aided in increasing the pink bollworm population in the lower Rio Grande Valley. Approximately twice as many worms were found in cotton squares and blooms in the spring of 1944 as in 1943. The average survival of pink bollworms in open bolls encaged on August 16, 1943, was 0.75 percent; on September 18, 7.93 percent; and on October 19, 32.05 percent. The average survival in bolls on standing stalks was 26.44 percent, in bolls on the soil surface 11.75 percent, and in bolls buried 4 to 6 inches 2.54 percent. The results of these experiments emphasize the importance of producing cotton early and plowing under the crop residue as soon as possible for control of the pink bollworm. Experiments indicate that the pink bollworm does not overwinter in free cocoons in the soil in this section.

In the Big Bend area high survivals during the winters of 1941–42 and 1942–43 and a prolonged planting period in 1943 following the removal of legal restrictions also aided in an increase of pink bollworms. However, the field clean-up, planting early maturing varieties, and early termination of irrigation have held the infestation below the levels recorded prior to 1938. As a result of late planting and late irrigation, some of the fields produced in 1943 large numbers of long-cycle larvae and the population entering hibernation was twice as large as in 1942.

The use of a special meter for indicating the percentage of moisture without disturbing the soil permitted a more accurate study of the effect of moisture on the mortality and time of emergence of pink bollworms. Apparently two or more irrigations with a drying-out period in between are necessary for complete pupation and emergence of adult bollworms. In the field a few moths emerge after the preplanting irrigation, but others delay emergence until the first or second irrigation of the cotton, when squares and bolls are present.

Dichloropropane-dichloropropylene (DD) at the approximate rate of 50 gallons per acre killed 81 to 100 percent of larvae in buried cotton bolls when injected into the soil at 18-inch intervals and at the same depth as the larvae, or added to irrigation water, but was ineffective when sprayed on the soil surface after burial of the bolls.

The infestation in secondary host plants was correlated with their time of fruiting and the intensity of the pink bollworm population in cotton. It was definitely established for the first time that the pink bollworm overwinters in the seed pods of *Pseudabutilon lozani* (Rose) R. E. Fries.

616016—44——3

BOLLWORM

Despite a high survival and heavy egg deposition early in the season, high temperatures and natural enemies greatly reduced bollworm damage. The most important predator was *Orius insidiosus* Say, though a number of other predators were factors in destroying over 20 percent of the eggs at Waco, Tex. Fewer bollworm eggs are destroyed when aphids are sufficiently numerous to provide an abundance of food for predators. This helps to explain why bollworms often increase following the use of arsenicals, which are known to cause a rapid increase in populations of aphids.

Cryolite diluted with 15 to 30 percent of sulfur gave as good bollworm control as the same poundage of undiluted cryolite, probably because the diluted cryolite has better dusting qualities and plant coverage. Greater dilutions were effective if the poundage of the mixture was increased so that 8 pounds of cryolite per acre was used. Cryolite-corn meal bait (1: 9 dry mixed) applied at 40, 60, and 80 pounds per acre gave satisfactory bollworm control. Forty or more pounds of bait per acre, scattered by hand, gave good plant coverage and gains equal to those obtained with 8 pounds of cryolite dust.

Reduced dosages of insecticides have not proved satisfactory for the bollworm; in fact, the recommended dosages are too small for best control. In 2-year tests the usual dosage of 8 pounds of calcium arsenate per acre gave an average gain in yield of 173 pounds of seed cotton per acre, 12 pounds of calcium arsenate gave 187 pounds, and 16 pounds of calcium arsenate 195 pounds. A 1:2 and a 1:1 mixture of basic copper arsenate and sulfur at 16 pounds per acre gave average gains of 195 and 300 pounds of seed cotton, respectively. A spray of 8 pounds of basic copper arsenate per acre was as effective as a 1:1 dust mixture of basic copper arsenate and sulfur or calcium arsenate dust at 16 pounds per acre.

Calcium arsenite was found to be more toxic against the bollworm than calcium arsenate, but caused so much injury to the plants it is not safe to use. A 1:9 mixture of dinitro-*o*-cyclohexylphenol and sulfur was less effective than calcium arsenate, and a 1:1 mixture of phenoxathiin and bentonite gave very little control.

PLANT BUGS AND STINKBUGS

It was necessary to begin control of plant bugs and stinkbugs about 2 weeks earlier and to continue control measures for a longer period in 1943 than normally. Large quantities of arsenical-sulfur dust mixture used in Arizona gave good control when dusting was started early and sufficient applications were used. In plot tests gains of 220 to 371 pounds of seed cotton per acre were obtained with 5 commercial mixtures. A mixture containing 5 percent of calcium arsenite in sulfur caused plant injury and a loss of 22 pounds per acre.

In an airplane-dusting experiment six applications of a 1:2 mixture of calcium arsenate and sulfur at 15 pounds per acre produced a gain in yield of 271 pounds of seed cotton per acre, or 30 percent, as compared with a gain of 158 pounds, or 10 percent, last year.

EFFECTIVENESS OF DDT ON COTTON INSECTS

In preliminary experiments against several cotton insects in Louisiana, Texas, and Arizona, DDT was found to be less effective against

the boll weevil than calcium arsenate, less effective against the cotton aphid than nicotine, and less effective against the cotton leafworm than arsenical insecticides. Encouraging results were obtained in experiments with the bollworm, pink bollworm, thrips, plant bugs, and stinkbugs, all of which have been difficult to control.

BEE CULTURE

HONEYBEES POLLINATE MANY AGRICULTURAL CROPS

The benefits from research in bee culture are not confined alone to improvement in the production of honey and beeswax. Whatever advancements are made in the handling of bees, such as in the control of bee diseases, swarming, and other problems facing beekeepers, at the same time improve the pollination of important agricultural crops. In evaluating research in this field this fact should always be kept in mind, inasmuch as the profitable production of about 50 crops rests upon the beekeeping industry. Since beekeepers are dependent upon honey markets, the role of honey in our economic welfare assumes unusual importance. In planning research in the field of bee culture it is therefore imperative that consideration be given whenever possible to the use of bees in pollination.

HONEYBEES IMPROVE SET OF ALFALFA SEED

A survey of alfalfa fields in Utah in 1943 showed that honeybees outnumbered the wild bees in the ratio of 1,000 to 1. Pollen-gathering honeybees tripped practically all blossoms visited, and in some areas more pollen was gathered from alfalfa than from all other plants, indicating that a substantial amount of pollination is effected by honeybees. Nectar-gathering bees, on the other hand, tripped only about 2 percent of the blossoms visited, but because of their preponderant numbers they are unquestionably an important factor in the production of alfalfa seed. Methods of handling bees that stimulate them to gather maximum quantities of alfalfa pollen should improve seed production. The proximity to alfalfa fields of competing mustard, thistle, sweetclover, corn, and other plants has an important bearing on the distribution of pollinating insects in the alfalfa.

The yields of alfalfa seed in Utah declined from 6½ bushels per acre in 1925 to 1½ bushels in 1942. This decrease in productiveness may be attributed largely to the decimation of native pollinating insects and to an apathetic beekeeping industry caused by years of low honey prices.

INSECTICIDES VS. BEE LOSSES

Samples of bees from 115 dead colonies in Utah analyzed for arsenic showed that 95 contained sufficient arsenic to account for their death. Analyses of pollen stored in the hives in 63 dead colonies showed that 54 contained lethal amounts of arsenic. As little as 3 parts per million of arsenic trioxide in pollen was found to be harmful to the bees. Dusting operations on cotton and tomato crops in Arizona and California were responsible for the death of more than 10,000 colonies last year.

Although arsenic is the chief cause of bee poisoning, tests with DDT and with dinitro-*o*-cresol, both new spray materials the latter of

which is used for thinning fruit, indicate that they may become a menace both to pollination and to beekeeping. Neither of these materials was repellent to bees. A 0.05-percent concentration of DDT fed in syrup to honeybees acted as a stomach poison. Contact with a 10-percent DDT dust proved fatal to bees. Bees in contact with a surface sprayed with a 2-percent solution of DDT died within 6 hours. When brood and adult bees were sprayed with a 0.05-percent solution of DDT, the unsealed brood was killed within a few hours but the sealed brood and adults were unaffected.

All bees fed a 0.125-percent solution of dinitro-*o*-cresol in sugar syrup were dead within 24 hours. A 1.25-percent solution was neither repellent to bees nor effective as a contact poison.

HONEY YIELDS INCREASED BY SUPERIOR STOCK

Uniform testing methods were employed to compare the honey-producing capabilities of 9 lines of stock. In these tests 125 package-bee colonies which produced a total of 14,200 pounds of honey were used. The highest yielding colony, in spite of a poor to mediocre season, produced 250 pounds and the lowest 19 pounds. The average per-colony yield of the best line was 160 pounds, that of the poorest 52 pounds. The high-producing line was characterized by a narrow spread between the yields of the best and poorest colonies.

These tests indicate the need to develop superior lines of stock as a means not only of increasing profits in beekeeping but of improving pollination.

ADVANCES IN ARTIFICIAL INSEMINATION OF QUEEN BEES

Heretofore it has not been possible to use artificially inseminated queen bees in studies of practical beekeeping problems. Excessive losses of queens caused by long delays in the initiation of egg laying, as well as the abnormally short egg-laying period of inseminated queens, has precluded their use in field tests on honey production, resistance to disease, and other problems. By resorting to multiple inseminations, however, queens with the fecundity of naturally mated queens are now possible. The average number of sperms in drones ranged from 5.1 to 9.9 million, according to their age. In naturally mated queens the average sperm count was 5.7 million. Sperm counts from queens after one artificial insemination ranged from 2 to 3 million. An average of 5 million sperms per queen was obtained by using several drones. Multiple inseminations also advance the initiation of egg laying. Multiple-inseminated queens equaled or bettered naturally mated queens in egg-laying performance.

NEW TECHNIQUE FACILITATES WORK ON RESISTANCE TO DISEASE

Gradual increase in resistance to American foulbrood has been obtained through the F_6 generation with naturally mated queens. However, in the seventh and eighth generations, although resistance was maintained, it was not improved. Queens of the F_6 and F_7 generations artificially inseminated showed marked increase in resistance over the naturally mated ones.

INVESTIGATIONS OF INSECTS AFFECTING MAN AND ANIMALS

INSECTICIDES DEVELOPED AT ORLANDO ADOPTED BY ARMED FORCES

Three research projects undertaken at Orlando, Fla., on funds allocated by the Office of Scientific Research and Development sought to develop a satisfactory lousicide, an effective insect repellent against mosquitoes and other biting insects, and larvicides for malaria-carrying mosquitoes. By the middle of May 1943 the insecticide known as DDT was recommended for control of lice attacking man, and within a year it had proved its worth among troops and civilians in North Africa and Italy, especially in the control of a typhus epidemic in the Naples area. A mixture of three insect repellents was recommended during the year, and is in use by our military forces and their allies in different foreign lands. A new mosquito larvicide developed at Orlando is being used successfully by our armed forces.

NEW SPRAYS FOR CONTROL OF TICKS AFFECTING MAN

For killing ticks about the premises of camps, playgrounds, parks, kennels, and residences, a spray containing 5 percent of DDT was found to be very effective. An emulsion of this material caused no injury to the vegetation, and when applied at the rate of 1 pound of DDT per acre it gave control of the ticks for about 6 weeks.

For use about kennels and other locations where some temporary burning of foliage is not objectionable, a water spray containing 0.05 percent of nicotine and 1.5 percent of sodium fluoride applied at the rate of 75 gallons per acre killed all stages of *Ixodes ricinus scapularis* (Say) and *Dermacentor variabilis* (Say).

MOTHPROOFED FABRICS WITHSTAND LAUNDERING AND DRY CLEANING

The effect of laundering or dry cleaning on fabrics previously treated with mothproofing agents has been studied. Fabrics treated with such agents as Mitin SS concentrate (a sodium salt of tetrachlorodiphenyl ether phenylurea monosulfonic acid), Eulan CN (pentachlorotriphenylmethane sulfonic acid), and aqueous solutions containing sodium fluosilicate were washed in soap and water, or dry-cleaned from one to ten times, and then subjected to attacks of the black carpet beetle. The results indicated that moth resistance may be given by the manufacturers of suitings, overcoat materials, blankets, and other woolen fabrics. These tests have demonstrated also the practicability of treating woolens in the home with moth-resistant sprays.

NEW TREATMENTS SUCCESSFUL AGAINST SCREWWORMS AND FLEECE WORMS

In limited field tests a new smear formula, known as P-55, afforded good protection in wounds of animals from infestations by screwworm flies, but it was slightly less efficient than Smear 62, which is now in use. Since the new smear contains ingredients that are not critically needed for war purposes, it seems promising as a substitute for Smear 62. Wounds of animals infested with screwworms healed as promptly after treatment with P-55 as those treated with Smear 62, but further tests of this kind are needed under ranch conditions.

Early in the spring screwworms moved into northern grazing areas along with shipments of animals, but the prompt use of Smear 62 prevented most of the losses that would ordinarily have occurred among the infested animals. The pest became established in many localities where stockmen were not familiar with it or with the use of this smear, and in such instances the losses were avoided only because of the timely surveys and the advice given by Bureau workers and by the early procurement of Smear 62.

Some outstanding results have been obtained in preventing infestations of fleece worms (*Phormia regina* Meig.) with a mixture of benzene and a wetting agent. Further tests are needed on a larger number of animals on ranches.

With another formula used on laboratory animals it has been possible to reduce the time required for healing wounds infested with fleece worms, and the average number of reinfestations has been reduced from approximately four per animal to less than one. When this treatment is applied to the infested wool of sheep, it penetrates the fleece and kills all fleece worm larvae upon contact.

Screwworm infestations occur in wounds caused by horn flies. Sprays with DDT for the control of horn flies attacking beef cattle under ranch conditions have greatly reduced the fly populations as well as the number of severe injuries caused by bites of large numbers of flies on small areas under the belly, about the rump, and at the base of the horns. A spray containing 1 percent of DDT killed all horn flies that alighted on the treated animals for 1 week. Range cattle sprayed with ⅔ pint per animal of a 0.2-percent DDT emulsion remained almost entirely free of flies for 7 days.

ROTENONE EXTENDERS RECOMMENDED FOR CATTLE GRUB CONTROL

The practical use of rotenone-bearing powders when mixed with finely ground tripoli, volcanic ash, or pyrophyllite has been demonstrated under ranch conditions in the treatment of cattle for the control of cattle grubs. These diluents have been found to be much more effective than either sulfur or talc because they penetrate the hair better. Because of the good results obtained with them as diluents for ground cube or derris, they have been recommended for use in dusts for cattle grub control and as a means for extending the available rotenone. Sprays containing only finely ground cube or derris root in water also gave a high kill of cattle grubs. When applied at a nozzle pressure of 400 pounds or more, a suspension of cube or derris powder in water gave better results than when these powders were mixed with wettable sulfur or with a wetting agent in water. When the spray was applied at a low pressure, the addition of a small amount of sodium lauryl sulfate somewhat enhanced its effectiveness.

Dusts containing 10 percent of DDT were found to be almost entirely ineffective against cattle grubs.

NEW TREATMENTS FOR TICKS AFFECTING ANIMALS DEVELOPED

Investigations on control of the winter tick were concerned principally with washes that would kill all stages and protect horses against reinfestation. Considerable progress was made toward the development of a wash consisting of DDT and soluble pine oil in water.

With a nondrying adhesive containing an insecticide it was possible to protect the ears of cattle, sheep, and goats from the spinose ear

tick for 90 to 120 days. The spraying of salt troughs and the areas under them with equal parts of kerosene and used motor oil also destroyed many of these ticks. When both these treatments were used, marked reductions of tick populations in pastures were observed.

Tickicides containing 5 percent of DDT in nondrying adhesives were prepared and used in preliminary field tests against the Gulf Coast tick. The period of protection from reinfestation given by these formulas ranged from 3 to 5 weeks, whereas the materials now in use by ranchmen did not give protection for more than 8 days.

IMPROVEMENTS IN CONTROL OF LICE ON LIVESTOCK

In tests made in the interest of conserving rotenone, 2.5 pounds of cube powder (5 percent rotenone) in 1,000 gallons of water used as a dip killed all the motile stages of the short-nosed cattle louse. When 100 pounds of wettable sulfur was added to this dip, it was effective for a second dipping 2 weeks after the first. A dip containing 5 pounds of cube, without sulfur or with only 50 pounds of sulfur, did not kill all the lice when it was held for a second treatment. Other tests showed that wettable sulfur, without rotenone, used at the rate of 150 pounds per 1,000 gallons of water did not give satisfactory control of this pest.

DDT was found to be remarkably effective for controlling this and other less resistant species of cattle lice. As little as 0.06 percent of DDT in a water suspension gave complete mortality of the motile stages of all species of cattle lice.

Emulsions containing 0.1 percent of DDT killed the motile stages of all species of lice on Angora goats, and the material from a single dipping remained in the hair long enough to kill the young lice that hatched from the eggs.

INSECT IDENTIFICATION

More than 700,000 species of insects are already known, and a larger number still remain to be discovered and described. Many with significantly different habits, and consequently requiring different methods of control, are so similar that they readily pass for each other. Authoritative identifications by specialists are, therefore, prerequisite to the use of effective control measures. Moreover, specialized research in insect classification must be continued to provide an increasingly sounder basis for identification.

Identifications were reported for 59,956 insect samples contained in 33,668 lots. Of these 28 percent represented interceptions in imports from abroad and 29 percent collections made in the course of special surveys; 25 percent were from research and control activities of this Bureau and other Federal agencies; 9 percent from agricultural colleges and experiment stations of the various States and insular possessions; 5 percent from individuals, private agencies, and pest-control operators; and 4 percent from foreign governmental agencies and institutions, largely in the Western Hemisphere.

Research in insect classification and anatomy designed to improve the bases for exact identification in certain insect groups resulted in completion of 27 manuscripts, totaling 831 pages, for publication.

Direct assistance given the Army and Navy involved identification of approximately 2,000 samples of mosquitoes, mostly from the war

areas, and nearly as many samples of miscellaneous insects collected on Army transport planes operating abroad. It included also personal instruction to 122 officers in the identification of mosquitoes and other insects involved in the transmission of human diseases. In addition, the Medical Intelligence Branch of the Office of the Surgeon General of the Army has been furnished, upon request, pertinent detailed information on all insects of medical importance known to occur in specified foreign areas; and an annotated bibliography of the literature dealing with the yellow-fever mosquito, covering more than 1,200 published papers, has been prepared for the U. S. Public Health Service.

FOREIGN PARASITE INTRODUCTION

PARASITE IMPORTATIONS FROM SOUTH AMERICA

As an aid in the control of important insect pests of agricultural crops, a total of 16 consignments of parasites and predators were forwarded to the United States from Argentina, Uruguay, and Brazil, and 4 consignments were sent to Puerto Rico from Brazil.

Vegetable weevil parasites imported from Argentina and Uruguay consisted of 8,083 puparia of *Epiplagiops littoralis* Blanch., 4,370 cocoons of *Porizon* sp., and 195 cocoons of *Triaspis* sp. For use against various species of armyworms, 947 puparia of *Pseudoarchytopsis* sp. were forwarded from Uruguay and 271 *Phorocera* sp. and 248 *Calosoma argentinense* Csiki from Argentina. Importations of corn earworm parasites from Uruguay consisted of 169 puparia of *Actioplagia* sp. and 23 cocoons of *Paniscus* sp. A total of 2,195 puparia of *Paratheresia diatraeae* (Brèthes), a parasite of the sugarcane borer, were sent to Puerto Rico.

COOPERATION WITH STATE, TERRITORIAL, AND FOREIGN ORGANIZATIONS

Cooperative work with the Puerto Rico Agricultural Experiment Station included the foregoing shipments of sugarcane borer parasites from Brazil, and two consignments of 2,255 adults of *Hambletonia pseudococcina* Comp. received from that station for release against the pineapple mealybug in Florida. Two consignments totaling 600 adults of *Allotropa utilis* Mues. for test upon the Comstock mealybug and 200 cocoons of *Cryptus sexannulatus* Grav., a parasite of the codling moth, were received through the courtesy of the Canadian Department of Agriculture.

In furtherance of the cooperative work with the California Agricultural Experiment Station, 1,818 *Epiplagiops littoralis* Blanch., 4,370 *Porizon* sp., and 126 *Triaspis* sp. from South America were forwarded for rearing and release in that State. For the biological control of armyworms 481 adults of *Pseudoarchytopsis* sp., 133 *Phorocera* sp., and 169 *Calosoma argentinense* Csiki, also from South America, were forwarded to the Florida Agricultural Experiment Station for field release. Parasitized squash bugs were collected in Connecticut and New Jersey, and 1,175 puparia of *Trichopoda pennipes* (F.) were obtained from them for forwarding to the Washington Agricultural Experiment Station for rearing and release in that State. A total of 2,200 adults of the woolly apple aphid parasite *Aphelinus mali* Hald.,

were reared and forwarded to the Iowa Agricultural Experiment Station for field release.

The cooperative project for the biological control of the citrus blackfly on the west coast of Mexico was completed during the year. Twelve consignments of parasite material from the Panama Canal Zone yielded 8,767 adults of *Eretmocerus serius Silv.*, a species known to be very effective in other sections of tropical America, and these were released in 60 infested plantings in the States of Sinaloa, Nayarit, and Colima. The parasite is now well established, and its effectiveness in control should be evident in the near future. Other shipments of parasites to Mexico included 1 consignment of *Lixophaga diatraeae* (Towns.), a parasite of the sugarcane borer, and 3 of *Aphelinus mali* Hald.

CONTROL INVESTIGATIONS

TOXICITY TESTS AID IN FURTHER IMPROVEMENT OF AEROSOLS AND SPRAYS

The great demand by the armed forces for insecticidal aerosols and the critical shortage of pyrethrum made it necessary to intensify the search for substitutes for part or all of pyrethrum used in the aerosol dispensers. One new material has proved to be very promising, and a large number of formulas containing it have been tested. A thorough investigation is being made, however, before a final formula is recommended.

A number of commercial aerosol dispensers have been tested. Most of these are 1-pound containers equipped with valves for releasing whatever quantity of aerosol is needed to kill the insects in the space being treated. They were effective in controlling flies and mosquitoes except when the aerosol solution was discharged at too rapid a rate. With the present aerosol formula a discharge rate of 0.5 to 1.0 gram per second is most satisfactory.

In tests comparing the effectiveness of pyrethrum in an aerosol and in a deodorized kerosene spray, the aerosol was found to be superior. In delayed-action tests the aerosol was found to be much better, since it remains suspended in the air for a much longer time. Approximately 885 tests were made on 65 aerosol formulas to test their effectiveness in controlling the housefly and malaria and yellow-fever mosquitoes.

Approximately 375 tests were made with a large number of spray formulas to control disease-carrying mosquitoes. Materials were tested in deodorized kerosene and in emulsion form. The oil-base sprays were more effective than the water-base sprays per unit of toxicant, although the toxicity of the water-base sprays varied markedly with the formula used.

Pyrethrum still remains the outstanding insecticide for the destruction of adult mosquitoes. Two materials that act as synergists slightly increased the effectiveness of pyrethrum against the yellow-fever mosquito, but to a much less extent than in tests on houseflies.

Of 123 new materials tested as synergists for pyrethrum in fly sprays, 13 increased its toxicity.

Of 171 samples of new materials, some in various concentrations, tested against the housefly, 1 plant material and 4 synthetic organic compounds showed high toxicity. Two of the latter are related to

DDT. In addition, 2 materials that had been developed elsewhere and were submitted for testing were found to be more toxic to houseflies than pyrethrum.

TESTS OF SUBSTITUTE MATERIALS CONTINUED

The search for noncritical insecticide materials for use on food plants was continued. In preliminary tests on 130 samples of new materials, 14 synthetics showed toxicity to 2 or more species of leaf-feeding insects. Of the plant materials tested, preparations containing extracts of yam bean and sabadilla seed exhibited considerable toxicity to leaf-feeding larvae.

In tests of powdered sodium fluoride for relative killing power against the American cockroach, a sample approximately 30 microns in average particle size killed 50 percent, a 10-micron sample 65 percent, and a 5-micron sample 75 percent. One new material has been tested that equals or exceeds sodium fluoride in toxicity to these roaches.

In cooperative work with the Eastern Regional Research Laboratory of the Bureau of Agricultural and Industrial Chemistry on better utilization of nicotine as an insecticide, 244 new samples were tested on plant-feeding insects. Most of these samples (220) were preparations containing nicotine compounds plus a material intended to act as a synergist. Seven of the materials added to the nicotine dust increased the effectiveness of the preparation against 2 species of plant pests.

In cooperative tests five samples of four species of rotenone-bearing roots from Puerto Rico were tested for insecticidal action. A striking difference in the toxicity of extractives other than rotenone was found.

NEW FUMIGATION SCHEDULES DEVELOPED

Wartime shipping regulations and conditions prevent the fumigation of carlots of vegetables to conform to Japanese beetle quarantine regulations, prior to icing for shipment. New dosage schedules for methyl bromide were therefore developed that permit treatment under various conditions of precooling and icing, under which procedure produce can be shipped without delay.

Further research in vacuum fumigation of nursery stock for elimination of white-fringed beetle larvae has shown that the previously approved dosage schedules can be substantially reduced, with consequent material reduction in the danger of injury to certain types of plants. Additional treatment schedules have been developed, and these now cover the temperature range of 40° to 80° F.

SMOKE AEROSOLS SHOW PROMISE AGAINST AGRICULTURAL PESTS

The production of insecticidal aerosols by means of heat rather than by liquefied gas is being studied to determine their usefulness against agricultural pests. Preliminary field tests against gypsy moth larvae showed a high mortality several hundred feet from the generator.

INSECTICIDE INVESTIGATIONS

Chemical investigations relating to insecticides and fungicides were concerned largely with the development and improvement of insecti-

cides to meet war needs. Many synthetic organic compounds have been prepared for testing as insect repellents, lousicides, and mosquito larvicides. Investigational work was reported in 88 published articles, and 30 United States patents covering new insecticides and methods of application were granted.

DDT INTENSIVELY INVESTIGATED

As indicated elsewhere in this report, DDT has proved amazingly effective against a number of agricultural insects and is being used by the armed forces in ever-increasing amounts for the control of body lice and as a partial replacement for pyrethrum in aerosols. The Division of Insecticide Investigations has been intimately associated with the development of DDT for these purposes and has taken an active part in furthering its manufacture in this country. Specifications have been developed for a satisfactory grade of DDT, and manufacturers were assisted in meeting these standards. An extensive research program on DDT for the armed forces is being carried on under a transfer of funds from the Office of Scientific Research and Development. Suitable preparations of DDT also are being developed for use against agricultural pests.

AEROSOL DEVELOPMENT CONTINUED

With the increasing demand by the Army and Navy for aerosol bombs for the control of malaria mosquitoes and houseflies, it has been necessary to develop substitutes for the limited supplies of pyrethrum and Freon-12 (dichlorodifluoromethane). A formula containing a considerably decreased amount of pyrethrins and another insecticide was worked out. A mixture of propane and butane was shown to be satisfactory and safe as a partial substitute for Freon-12. The aerosol method has also been found effective for applying other insecticides in greenhouse and field against certain agricultural pests, as well as for applying hormones to plants.

SUBSTITUTES AND EXTENDERS FOR WAR-SCARCE INSECTICIDES SOUGHT

Inasmuch as imports of rotenone-bearing roots and pyrethrum have been greatly curtailed and other insecticide supplies restricted, the development of substitutes or means of extending the supply has become of great importance. A number of synthetic organic compounds have been found effective as synergists for pyrethrum. It was shown that anethole can be substituted for geraniol and pimento-leaf oil for eugenol in Japanese beetle bait without adverse effect. Extracts of the plant *Erigeron affinis* DC. proved very toxic to houseflies and to some other insects. A mixture of soybean phosphatides and raw mineral oil was found to be a satisfactory substitute for soybean oil as a spreader and adhesive for lead arsenate and nicotine bentonite sprays.

PURE PYRETHRINS PREPARED

A method was devised for the preparation of practically pure pyrethrins from commercial pyrethrum extracts with very little loss of pyrethrins. This pure material is completely soluble in Freon-12 and

is well suited for use in aerosols. The pure pyrethrins also proved to be of use in the preparation of analytical standards for pyrethrum.

ANALYTICAL AND SERVICE WORK

Approximately 900 samples of miscellaneous insecticides were analyzed, most of them for other divisions of this Bureau and for the Foreign Economic Administration. Analytical methods were developed for DDT, for certain dinitro compounds, and for the determination of free lime in calcium arsenate and of sesamin in sesame oil.

MEXICAN FRUITFLY CONTROL

The area quarantined on account of the Mexican fruitfly now covers all the citrus-producing portion of Texas, but the infestation has not extended beyond the section adjacent to the Republic of Mexico. The citrus industry in Texas has had a phenomenal growth, and the inspection, sterilization, and certification of the approximately 50,000 cars of citrus fruit produced annually has become a problem of increasing importance. Although the possibility of permanently eradicating the Mexican fruitfly appears to be remote, the danger of its spread through the shipment of infested fruit has been drastically reduced by the requirement that all fruit from infested zones be sterilized before shipment. The amount of fruit treated during the season of 1943–44 increased almost 200 percent over the previous year. A total of 4,263 equivalent carlots of fruit were sterilized without injury to the fruit and at very little additional cost to the packer. Because of the general adoption of the fruit-sterilization process, which was developed by the Department in 1929, a lengthened harvesting season was made possible. The harvesting season for grapefruit produced in the regulated area was extended from April 30 to June 15, and that for Texas oranges was extended to include the entire year. The infestation in the regulated area developed somewhat later than in some previous seasons.

Tables 1 and 2 give data on the number of infestations and the amount of fruit sterilized in Texas since control of this insect was undertaken.

TABLE 1.—*Infestations of Mexican fruitfly in Texas, fiscal years 1935–1944*

Fiscal year	Flies trapped	Larval infestations	Date harvesting season closed [1]
	Number	*Number*	
1935	371	30	April 2.
1936	256	5	March 31.
1937	4,714	1,062	Do.
1938	712	218	April 30.
1939	13,687	2,141	{May 15 (G). June 15 (O).
1940	6,157	[2] 582	April 30.
1941	979	552	May 31.
1942	244	259	Do.
1943	224	291	Do.
1944	1,796	576	{June 15 (G). No closing (O).

[1] (G) Grapefruit, (O) oranges.
[2] Includes 4 infestations in 1939.

TABLE 2.—*Tons of citrus fruit sterilized in Texas, fiscal years 1939–1944*

Fiscal year	High-temperature method		Low-temperature method	
	Grapefruit	Oranges	Grapefruit	Oranges
1939	44,150	2.25	0	2.1
1940	8,927	.75	298.6	168.8
1941	9,937	0	53.6	0
1942	3,619	0	0	0
1943	23,394	0	0	0
1944	62,372	26	0	0

JAPANESE BEETLE QUARANTINE AND CONTROL

TRAP SCOUTING IN NONREGULATED TERRITORY

Trapping to determine the spread of the Japanese beetle in 1943 largely paralleled that of the previous year. With the necessity for conservation of traps and labor, most of the activities were confined to localities in which combined trapping and soil-treating work had been carried on in previous years, or in which incipient or appparently negligible infestations had been discovered. This left a few traps for setting in localities not previously trapped. From the 55,354 inexpensive scout traps used in 1942 it was possible to salvage 41,993 for the current year's activities. As in 1942, trapping was performed in 17 States, but the number of localities was reduced from 242 to 161. Beetles were captured in 107 communities, in 12 of them for the first time.

An important development of the year was the discovery of a heavy infestation at Blowing Rock, N. C., in the mountains in the northwestern section of the State. Over 17,000 beetles were trapped at this point, which is remote from any other known infestation. At Hendersonville, N. C., where 1,718 beetles were trapped in 1942, only 785 beetles were collected this season. Beetles were collected in 17 other North Carolina localities where they had been trapped in previous years.

Cooperative Federal-State trapping in Maryland showed relatively heavy infestations in Hancock, Hughesville, and Siebert, in addition to four other negligible infestations in the nonregulated area.

In New York State trap captures in Canandaigua, Dunkirk, Lyons, Medina, Newark, North Tonawanda, and Plattsburg were of a few beetles each. Infestations persisted in Avon, Jamestown, Silver Creek, and Waterloo. In Newark and Niagara Falls, where treatments had been applied in previous years, the captures were reduced to 1 and 71 beetles, respectively, compared with 65 and 216 beetles in 1942. Beetles collected at Geneva and Ogdensburg indicate increased infestation there. Trapping in Westfield disclosed 27 beetles.

In Ohio negligible first-record collections were made at Fostoria, Fowlers Mill, Lima, and Willard. In Bellevue, East Conneaut, Gallipolis, Rockbridge, and South Zanesville fewer beetles were turned up than in 1942. Increases were noted in Ashtabula and Marietta. The remaining infestations persisted at about the 1942 level.

In Pennsylvania trapping was limited to a group of traps in Greenville, where 14 beetles were caught.

In Virginia 25 beetles were trapped at Lynchburg, the largest number taken at any point in the nonregulated area. Approximately the same number were collected in Bristol, Harrisonburg, Lexington (first record), and Woodstock, with lesser numbers at Luray, Staunton, Waynesboro, and Williamsburg.

In West Virginia half of the 6 localities where beetles were trapped this year were first records. The only captures of consequence were 21 beetles at Princeton and 19 at Williamstown.

All trapping in three cities each in Florida and Wisconsin was with negative results.

Trapping in Georgia showed that infestations had persisted in Atlanta, Augusta, East Point, and Toccoa.

Collections in Illinois indicate a reduction in the infestation at Highland Park, but increases at both Chicago and East St. Louis. Solitary beetles were trapped in Cicero and Oak Park.

In Indiana the capture of only 17 beetles at Richmond where 556 had been trapped in 1942 indicates a substantial reduction in the infestation there. Infestations in 4 other localities remained at about the same level.

In Michigan beetles were caught in five localities in which infestations had been found in previous years.

In Missouri 14 beetles were collected at St. Louis, as compared with 6 caught there last year.

In South Carolina beetles were again trapped in Florence and Greenville.

Trapping in Tennessee resulted in the capture of five beetles each in Kingsport and in the Tennessee portion of the city of Bristol.

SUPPRESSIVE MEASURES

The combined trapping and soil-treatment programs in infested localities outside the regulated area and in nonquarantined States, together with State quarantine action as to certain outlying areas, assured protection from spread comparable to that that would have been obtained if the Federal quarantine had been extended.

Applications of lead arsenate were made with State cooperation at 53 isolated infestations in 10 States. Fall treatments comprised 796 acres, with an additional 95 acres covered in the spring. The total acreage was less than had been necessary to suppress the isolated infestations treated during the previous year's cooperative State-Federal soil-treating program. Spores of the milky disease of the Japanese beetle grub were distributed at Asheville, Blowing Rock, and Henderson, N. C., in cooperation with the Division of Fruit Insect Investigations.

Largest of the soil-treating programs were those in Ohio, Illinois, Michigan, and North Carolina, where 233, 177, 149, and 143 acres, respectively, were treated.

Additional acreages treated were New York 73, Indiana 68, Virginia 22, Missouri 13, Tennessee 8, and Georgia 6.

MODIFICATION OF QUARANTINE REGULATIONS

A revision of the Japanese beetle quarantine and regulations was issued effective March 30, 1944. Provisions were made for more flexi-

bility in the handling of seasonal and local problems through the issuance of administrative instructions by the Chief of the Bureau. Only small additions were made to the regulated area, and the heavily infested area remains the same except for the inclusion of the township of West Leesport, Berks County, Pa.

HIGHWAY INSPECTION SERVICE

The road-patrol work for 1943 continued on the same basis as in the previous year, the inspection being confined to examination of motor trucks. By July 6 eight road stations were set up. One of these operated until July 24, and the remainder until the first week in September. Thirty inspectors were assigned to this work. During the season 94,748 trucks were inspected. Of these, 703 were found to be transporting uncertified produce, but 504 lots of produce were certified at inspection centers located near the highway stations. Inspectors at the road stations examined and certified 143 shipments and issued permits for the movement of 55 truckloads to isolated regulated areas. Only one violation of the regulations was recorded during the season. Inspectors intercepted 596 southbound empty trucks, from which 3,823 live Japanese beetles were removed. An additional 46 beetles were taken from the small lots of farm products examined at the stations.

CERTIFICATION AND TREATMENT OF NURSERY STOCK

Nurseries entitled to a noninfested status under modified regulations numbered 669 at the end of the fiscal year. The classification system previously used was discontinued owing to the revision of the regulations. Authorization of new methods of chemical treatments that may be utilized for plants with soil about the roots has removed the necessity for screening greenhouses or treating potting soil or field plots.

New administrative instructions to inspectors on treatments used as a basis of certification under the Japanese beetle quarantine, issued on September 10, 1943, provide the freest possible use of the various treatments and utilization of new facts as they are developed.

Use of the ethylene dichloride dip increased in popularity from month to month. A total of 708,515 plants were treated in this manner during the year. Many small nurseries adopted this treatment as a means of qualifying their plants for certification. These establishments had previously refused orders going outside the regulated area because of the labor and expense entailed in existing methods of certification. The dip treatment is cheap and easy, and its use permits acceptance of all outside orders, no matter how small. The temperature requirement for the dip has been brought down to 35° F. By this method a carload of 152 *Taxus* plants with 21- to 24-inch soil balls was dip-treated by 5 men in less than 4 hours. The soil balls absorbed 370 gallons of the emulsion. By placing his tank of emulsion in a box car another nurseryman was able to dip his stock as it was being loaded.

For the information of nurserymen and greenhousemen a list of plants treated commercially with ethylene dichloride during October, November, and December was distributed on December 30, 1943.

In cooperation with the Division of Fruit Insect Investigations, tests were made of the ethylene dichloride dip treatment of nursery stock with soil balls up to 30 inches in diameter.

Chloropicrin was approved as a fumigant for bulk soil in the absence of plants. Methyl bromide fumigation of nursery stock after loading in tight box cars was authorized and was utilized by nurserymen during the year.

During the adult beetle flight in the summer of 1943 from 2 to 4 scoutings were made of 861 nurseries and greenhouses in which infestations had not previously been determined. Infestations were found in approximately 100 establishments.

CERTIFICATION OF FRUITS, VEGETABLES, AND CUT FLOWERS

Inspection and certification of fruits and vegetables during the 1943 period of flight of adult Japanese beetles was concentrated at 27 inspection centers scattered throughout the heavily infested area. During the fiscal year inspectors removed 1,087 beetles from 2,339,196 packages of commodities certified for distant movement. Certification of this produce involved the methyl bromide fumigation of 5,692 loaded refrigerator cars and 61 loaded trucks, and the hydrocyanic acid fumigation of 252 empty refrigerator cars. Ninety-five beetles were taken also from 7,887 packages of cut flowers inspected during the summer.

Experimental work was completed on which to base methyl bromide fumigation of refrigerator cars at temperatures as low as 40° F., thereby permitting their fumigation while iced. Previously cars to be fumigated had to be uniced. These low temperatures were authorized for use during the summer of 1944.

ARTICLES CERTIFIED AND VIOLATIONS INVESTIGATED

Nursery stock moved under certification in lesser quantity than last year. From infested establishments 26,637,568 plants and 648 tons of soil and manure were certified. In addition, 15,902,721 plants were shipped under certification from noninfested premises. Moreover, 29,811,009 plants and 1,669 tons of soil and manure were certified for movement between dealers within the regulated zone.

To cover quarantined products moving to nonregulated territory, 199,053 certificates of all types were issued.

Investigations were made of 481 apparent violations of the quarantine regulations.

PHONY PEACH AND PEACH MOSAIC DISEASE CONTROL CONTINUED IN 16 STATES

Federal-State surveys and inspections for the phony peach and peach mosaic diseases were conducted in the summer of 1943 in 16 infected States from South Carolina to California. These inspections were made in commercial orchards and other peach plantings. Growers gave more assistance than for many years despite the manpower shortage. The lifting of the standard State phony-peach quarantines from 18 additional counties—1 in Illinois; 3 each in Arkansas, South Carolina, and Tennessee; and 8 in Texas—having a 3-year disease-free status, reflects continued progress in controlling this disease. No additional counties were found infected with the phony disease. The standard peach-mosaic quarantine was modified to remove Salt

Lake County, Utah, from the regulated area. Mosaic was found in Alfalfa and Woods Counties in Oklahoma. In the spring of 1944 the annual inspection was made in infected areas of all nurseries and their 1-mile environs. The number of nurseries ineligible for certification has decreased annually, and there has been no record of spread of these diseases through nursery-stock shipments in the last 6 years.

The apparent eradication, since 1936, of the phony disease from 6 entire States and a 98-percent reduction in 8 others made it possible in 1943 to direct greater attention to the heavily infected States of Alabama and Georgia, where 48,790 phony trees (68 percent less than in 1936) were found and destroyed.

With the cooperation of Mexican pest-control officials, inspection was made in the Juarez Valley, Chihuahua, and 947 mosaic trees were found on 170 of the 192 properties inspected.

SURVEY FOR ORIENTAL FRUIT MOTH IN NINE WESTERN STATES

The survey in the spring and summer of 1943 for the oriental fruit moth resulted in the discovery of infestations in parts of 62 counties extending from northeastern Texas through parts of Oklahoma, eastern and east-central Kansas, southeastern Nebraska, and southern Iowa. Following the twig inspections, trapping operations for adult moths resulted in locating an infestation in an additional county in west-central Kansas in September. In the spring of 1944 a more intensive inspection and trapping program was instituted, and was under way, at the close of the year, in the more important fruit areas of Arizona, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, and the El Paso Valley of Texas. The moth has not previously been found in these areas. The States have rendered assistance in both years.

NO TRACE OF CITRUS CANKER FOUND

Federal-State inspection for citrus canker was conducted from October 1943 to March 1944 in 35 Texas counties, including vicinities of 44 nurseries, without finding the disease. Formerly infected areas in Brazoria, Galveston, and Harris Counties and the town of Hamshire in Jefferson County were intensively inspected for any vestige of this highly infectious bacterial disease. Particular attention was given to old hedges of trifoliate-orange at Navasota, where citrus canker was last found in this country in 1943. As no Federal funds were made available for the work in 1945, Bureau participation in this activity was discontinued June 30, 1944.

GYPSY AND BROWN-TAIL MOTHS CONTROL

Gypsy moths are known to be present only in a relatively small part of the Northeastern States. The object of control is to protect our forests by eradicating this destructive insect from the isolated area of infestation in northeastern Pennsylvania and by preventing its spread from the infested area in eastern New York and in New England. The program is sufficiently flexible to allow prompt modification whenever developments of research or control procedure in-

dicate need for change, or to provide for expansion at the termination of the war.

NEW AND VERY EFFECTIVE METHOD OF CONTROL INDICATED

During the year DDT was tested on an experimental control basis against gypsy moths. A 20-acre woodland tract in Pennsylvania and a 5-acre wood lot in New York, in which rather heavy infestation existed, were treated with DDT in concentrated spray form at the rate of 5 pounds per acre. The spray was applied by a specially constructed spinner-disk apparatus attached to a biplane. Application was made in the Pennsylvania tract early in May before leaves had developed and prior to hatch of gypsy moths. In New York treatment was applied after leaves had fully developed and when gypsy moths were in the second larval stage. From a relatively few hours after the treatment to the close of the fiscal year no living gypsy moths were found in either tract.

Other small-scale demonstrations with DDT as an emulsion, in aerosol form, and in a dilute spray mixture were conducted. All methods proved to be spectacularly effective against gypsy moths in all stages of larval development. As a final check all treated areas will be carefully observed through the egg-laying season.

It is believed that, when available for the purpose, application of DDT by aircraft will afford a cheaper and much more effective method of control and eradication of gypsy moths than any method previously used.

These experiments with DDT in spray form were carried out cooperatively with the Division of Forest Insect Investigations, and those with the material in aerosol form with the Division of Control Investigations.

PROGRESS IN PENNSYLVANIA

The effectiveness of gypsy moth control is evidenced by the fact that at the close of the year the size of the infested area in Pennsylvania had been reduced to 556 square miles. This is in comparison with an area of 1,040 square miles in 1938. As a result the State quarantine was revised to remove from regulation more than 400 square miles where infestation had previously existed.

SPECIAL EMPHASIS PLACED ON SURVEYS

During the year surveys were conducted on more than 4 million acres within and beyond the limits of spread of the gypsy moth, by using a sex attractant. While no additional infestations were found beyond the area of general distribution in Pennsylvania, the gypsy moth was detected in New York State in several townships north and northeast of Albany and Schenectady Counties, where infestation had been discovered by the same type of survey during the previous year. This spread increases the extent of areas needing treatment, but since the wood lots in these areas are small compared with the acreage in pastures and under cultivation, the application of extensive control and eradication methods when manpower and materials are available should result in elimination of this westward extension of infestation.

NEW DEVICE FOR DISTRIBUTING CONCENTRATED SPRAYS FROM AIRPLANES

In previous seasons insecticides to control gypsy moths from aircraft have been applied only in dust form. Satisfactory adherence of the dust to foliage could not be secured. This season lead arsenate and cryolite in concentrated spray form were distributed from a specially devised spinner-disk apparatus attached to a biplane. The mortality of gypsy moths approximated 100 percent in all areas treated with lead arsenate, and reasonably satisfactory control was obtained in the areas treated with cryolite. The aerial method of application of insecticides for gypsy moth control is now considered to have passed the experimental stage; its effectiveness and economy of operation have been demonstrated.

COOPERATION WITH OTHER AGENCIES

As a result of the cooperation of State agencies, Bureau research units, and the public, surveys were conducted on a larger acreage than was covered in any previous year; the adhesiveness, and consequently the effectiveness, of the insecticides was increased; and other project activities were performed with a considerably reduced personnel.

Cooperative control on an experimental basis was conducted with the Dominion of Canada against the spruce budworm and with New York State against a destructive species of sawfly, to determine the effectiveness of distributing new insecticide formulas with the spinner-disk type of apparatus attached to aircraft. Preliminary observations indicate that very effective control was obtained.

INCREASE IN INTENSITY OF INFESTATION

A decided increase in intensity of gypsy moth infestation has been noted in a small area in Pennsylvania and in the north-central portion of Massachusetts. From observations made at the close of the year, it is estimated that more than 200,000 acres of forest land were severely damaged by heavy to complete defoliation, compared with 35,000 acres during the previous year. During the last 3 years gypsy moth populations, except in the Cape Cod area of Massachusetts, have been at the lowest ebb since 1924.

BROWN-TAIL MOTH CONTROLLED BY STATES

Brown-tail moths are present only in the four northern New England States, and all work on control during the year was conducted by the affected States. Very little defoliation or heavy feeding was noted, except in a few areas along the coast near the Maine-New Hampshire State line.

CERTIFICATION OF PRODUCTS UNDER THE GYPSY AND BROWN-TAIL MOTHS QUARANTINE

Gypsy moth infestation resulted in little defoliation in the summer of 1943, according to reports of district inspectors stationed throughout New England. This was not the situation in June 1944, however. Enormous damage to woodlands by gypsy moth larvae was reported in sections of Massachusetts, Maine, and New Hampshire, particularly in the Cape Cod and Northampton-Belchertown areas of Massachu-

setts. Caterpillars bunched in a layer 6 inches deep were observed in June at Florence, Mass.

Owing to the lighter infestation during most of the year, there was a further reduction in the number of infestations removed from inspected products. In the inspection of 90,056 shipments, 349 egg clusters, 230 larvae, and 18 pupae of the gypsy moth were removed.

Improvisations and substitutions in the lumbering industry required more than usual vigilance on the part of inspectors supervising shipments of wood products. Many items that under normal conditions are considered undersized or waste were utilized in the effort to meet the extraordinary demand for lumber and other wood products for war uses. In some cases lumber has been inspected on the day that the trees from which it was cut were felled. Some of this unseasoned material is shipped "round edge," so that inspection of each board is required. Many egg clusters have been discovered during inspection of this green material. The last of the pond storage sites for 1938 hurricane lumber was emptied during the year, and the logs were processed. White pine of small diameter and poor quality was also felled and shipped under inspection for use in blocking and crating such war materials as jeeps, coastal targets, light and heavy trucks, guns of all sizes, and tanks.

The use of edgings, formerly a waste product of lumber mills, as crating material added another item to the inspection list. Used railroad ties by the thousands were ripped up from abandoned rail lines in infested sections and shipped to distant points. Inspection of one lot of 2,708 ties destined to nonregulated territory resulted in the removal of 84 egg clusters.

An Army officer moving from Falmouth, Mass., to Chevy Chase, Md., presented a child's collapsible play pen for inspection. Fifty-six gypsy moth egg clusters were removed from the pen before it was certified.

Movement of pulpwood to paper mills in northeastern New York was facilitated by scouting of lots from which most of the wood is cut. Certification is granted for all wood from uninfested lots. A limited permit agreement was signed by one of the largest paper mills in New York, under which permits are issued for the rail movement of uninspected wood to that mill for immediate grinding into pulp.

A survey of all junk yards, a total of 101, within the infested area was made from February to April. Gypsy moth infestation was found on or near the premises of 13 of these. In 4 yards egg clusters were found on the stored junk. Arrangements were made for the inspection of any of this material that was intended for shipment outside the infested zone.

On two occasions inspectors were stationed on certain highways leading from the infested area. While heavy movements of Christmas trees were in progress in December, 8 inspectors formed a roving patrol on the principal exit highways. They intercepted 23 truckloads of uncertified Christmas trees and in most cases induced the drivers to return to the regulated area for disposal or inspection of their load. One consignment of trees was destroyed at the point of interception. For 10 days during June one of the regular inspectors was assigned to road-patrol work in western Vermont. Three uncertified truckloads, one each of lumber, pulpwood, and granite, were intercepted,

and not permitted to proceed until they had complied with certification requirements.

Inability to hire temporary inspectors greatly curtailed the force engaged in Christmas-tree inspection. Whereas normally 30 inspectors are used, this year only 3 temporary men were employed. This situation was alleviated by the shift from piece-by-piece, visual inspection to fumigation of the trees after loading in box cars. Three times as many Christmas trees were moved under certification from the regulated area during November and December as were shipped the preceding season. In all, 419,133 Christmas trees were certified. Of these, 262,818 trees were shipped in 136 box cars after fumigation with methyl bromide. Last season only 34 carloads were fumigated. Further to facilitate Christmas-tree fumigation, tests were made in February of methyl bromide applied at low temperatures.

Among the products shipped in large quantities that were inspected and certified during the year were the following:

Lumber	board feet	190,358,725
Logs, piles, poles, ship knees, and ties	pieces	318,479
Shavings	bales	98,237
Pulpwood	cords	51,428
Cable reels	number	46,087
Miscellaneous forest products	pieces	118,454
Shrubs	number	2,778 203
Young trees	do	208,084
Specimen evergreens	do	643,001
Young evergreens	do	2,224,424
Seedlings and small plants	do	502,092
Boughs, balsam twigs, and mixed greens	boxes or bales	26,680
Christmas trees	number	419,133
Granite	pieces	2,718
Paving blocks	number	25,500

DUTCH ELM DISEASE ERADICATION

In February all federally-financed tree removal in connection with the Dutch elm disease control program was discontinued to conform with a proviso in the current Agricultural Appropriation Act leaving to States and property owners the responsibility for removing trees in which the causal agent of the disease has been found. In this revised program the emphasis has been shifted from eradication of known sources of the disease to the maintenance of a constant watch on its spread so that quarantine measures may be enforced. Large-scale field experiments were undertaken to determine what action, if any, may be taken by individuals, municipalities, or other political units to protect valuable elms from this disease when it occurs generally in the area.

SCOUTING FOR DISEASED OR BEETLE-INFESTED ELMS

Scouting during the summer of 1943 included a band of territory approximately 15 miles wide along the perimeter of the major disease area, the outlying disease centers of Indianapolis, Ind., Cumberland, Md., and Athens, Ohio, as well as exploratory scouting in the Mississippi and Ohio River valleys, and near Boston, Mass., and Baltimore, Md. A small amount of work was also done at Norfolk and Portsmouth, Va., and Brunswick, Md., where the disease occurred in pre-

vious years. Summer scouting was terminated early in October, and the winter scouting program, which was to continue through the remainder of the fiscal year, was begun in December.

Supplementing the scouting on foot and in automobiles during the summer of 1943, extensive trapping of elm bark beetles was undertaken by piling elm logs or other attractive elm material at selected points in the work area for the purpose of supplying beetle specimens for laboratory culturing. About one-third of the trap logs became infested with bark beetles. A few of the samples of wood and bark cut from the infested material disclosed the presence of the disease in the locality.

First-record infections were reported from 120 towns, townships, and boroughs—15 in Connecticut, 3 in New Jersey, 32 in New York, 8 in Maryland, 3 in Massachusetts, 31 in Pennsylvania, and 28 in Ohio.

Spread of the disease, as evidenced by both summer and winter scouting, was rather extensive in New York, with more moderate increases of territory in Pennsylvania and Connecticut. Only a few scattered new infections were reported from New Jersey and Massachusetts. Westward progress of the disease in all the main infested areas appears to have been greatly retarded this year. At Indianapolis no additional territory was found invaded. There was a somewhat uniform and large expansion of territory in the vicinity of Athens, Ohio.

First-record infections discovered in New York extended the isolated area at Binghamton roughly one tier of towns northward and two tiers eastward. The principal additions to the main New York area were eastward in Columbia and Rensselaer Counties.

Extensions of the disease in Pennsylvania were largely southwestward in Delaware and Chester Counties plus infections discovered in intervening towns in Montgomery County that had previously been surrounded by disease areas. This filling in of sections already surrounded by disease areas also caused increases in infection in the Wilkes-Barre isolated zone.

Eastward extensions of the disease in Connecticut were confined largely to confirmations of one or a few trees each in towns near known disease territory, several instances of infection being found in intervening territory.

The three first records discovered in New Jersey connect what had previously been an isolated infection with the main disease area in Burlington County.

The first-record confirmations in Massachusetts were in Berkshire County in the town of Mount Washington, already surrounded by towns in which the disease had been found; in West Stockbridge, adjacent to the known disease area; and in Pittsfield, one town removed from the nearest known disease case. All of the 13 diseased trees found in the State during the year were eradicated with State cooperation.

In Maryland early-winter scouting in the vicinity of the former Brunswick disease area disclosed 8 diseased trees, 6 in the Monocacy River valley north of Frederick, and 2 trees 2 miles north of the Potomac River and 3 miles west of the Monocacy. The outermost of these were slightly more than 20 miles apart. Additional men were assigned to this territory for exploratory scouting. During March ten addi-

tional confirmations were reported, and late in May and early in June 4 more were discovered, giving a total of 22 in this general area. These trees, plus some associated beetle material, were eradicated by the State. The total area involved is a strip 30 miles wide running northeast through central Frederick County. This is the first reappearance of the disease in Marylnd since 1941, and in Frederick County since 1935, when 3 diseased trees were found in Brunswick.

The exploratory scouting indicated that the *Scolytus multistriatus* (Marsh.) infestation near Boston is continuous through Massachusetts to the main disease area in New York, where these bark beetles are the principal carriers of the fungus causing the disease. A scout crew traced an infestation of this species down both sides of the Mississippi River as far as northern Mississippi and west of the river in Arkansas. *S. multistriatus* was also found well established in the Indianapolis area.

In the effort to develop means whereby individuals or municipalities may protect their own trees from the Dutch elm disease, experimental plots have been established at Morristown, Princeton, and Ridgewood, N. J. At Morristown a circular area having a radius of 3 miles is being intensively scouted as in former years. In the inner 2 miles trees showing symptoms of the disease are removed as promptly as possible, the outer mile serving as a buffer zone. In this inner area confirmations from 1939 to 1942 numbered 72, 13, 7, and 22, and increased to 140 in 1943.

As a check on disease incidence within the heavily infected territory where organized control work has been abandoned, scouting was continued in plots each 5 miles in radius at Princeton and Ridgewood, N. J. Here also pronounced increases in the number of diseased trees were found this year. The Ridgewood plot in 1943 yielded 292 confirmations, as contrasted with 115, 85, and 71 in the 3 preceding years. Confirmations at Princeton increased from 75, 93, and 16 to 208 confirmations in 1943.

Scouts submitted 14,213 samples to the laboratory for culturing; 1,736 of these were infected. Connecticut had 122 confirmations, Massachusetts 13, New Jersey 845, New York 386, Pennsylvania 252, and in the isolated infected areas Maryland 22, Ohio 92, and Indiana 4. Of the New Jersey confirmations, 809 occurred in experimental check plots inside the disease area. Since area-wide, systematic eradication work was discontinued in 1941, total confirmations for this year or either of the previous 2 years are not indicative of intensification or diminution of the disease in the main area.

Cumulative totals since discovery of the disease in 1930 show 67,374 known cases of the disease. Of these 2,026 have been found in Connecticut, 20 in Massachusetts, 50,847 in New Jersey, 12,843 in New York, 1,265 in Pennsylvania, and 373 in the isolated areas.

ERADICATION AND SANITATION ACTIVITIES

Prior to abandonment of tree-removal work in February, crews had destroyed 510 confirmed trees and 1,157 elms or other elm material containing bark beetle infestation. During the remainder of the year, through State and municipal cooperation, an additional 43 diseased trees and 60 beetle-infested items were eradicated. In addition, 198 elms were pruned of bark beetle material.

There were 1,645 known diseased trees standing at the end of the fiscal year, plus 71 trees that had been pruned over a period of years and kept under observation.

A revision of the quarantine embargo that prohibits the interstate movement of elms and elm material from the infected zone to outside points was under consideration at the end of the fiscal year. Some movement of nursery elms was authorized during the year under precautionary restrictions and on an experimental basis.

WHITE PINE BLISTER RUST CONTROL

Control of the blister rust disease is essential to the maintenance of the white pine forests of the United States. The accomplishments of the last 25 years are reflected in the amount of lumber available for war purposes and in the young growth for the next forest crop. Stands of white pine initially protected from blister rust in the earlier years of the control program are being harvested, and the young growth now receiving protection by eradication of ribes, alternate host plant for blister rust, will provide lumber for the future. Over 2 billion board feet of white pine lumber were used during each of the last 3 years in connection with the war program. Accelerated cutting of white pine caused by war demands continued during 1943, and the need for adequately protecting the young growth, which is soon killed by blister rust, becomes of increased importance in providing for future crops of this valuable wood.

EFFECT OF WAR ON CONTROL PROGRAM

Conditions resulting from the war emergency continued to handicap the control program and to increase the difficulties of field operations, although some regions experienced less trouble than others. There were varying degrees of labor shortages in different areas, and a scarcity of many items of supply and equipment. The unavoidable restrictive orders and regulations resulting from these shortages, such as priority ratings, wage and labor stabilization policies, food and gasoline rationing, and restricted travel, greatly increased the problems and difficulties of carrying on field work. In some regions the general scarcity of labor in forest areas, or its employment on urgent war projects, resulted in greater use of blister rust crews on emergency fire-suppression work. Also, some of the permanent field personnel were temporarily detailed to aid the timber-production war project, and other urgent war activities were given assistance, when this could be done by employees without serious detriment to their regular work.

Field work was adjusted to meet war conditions by using labor outside draft age, mostly young men from 16 to 17 years of age, by temporarily releasing men for farm work, by restricting travel and the use of equipment and supplies to bare essentials, by adopting a holding program for the duration of the war, by revising work schedules to maintain control on protected areas, by giving priority to areas requiring rework, and by assisting other war projects wherever practicable.

PROGRESS OF CONTROL WORK

There are about 28 million acres of white pine control area in the United States. This area fluctuates from year to year, being decreased by logging, fire, and other causes and increased by natural

reproduction and planting. The initial eradication of ribes has been completed on over 22 million acres of the net control area, and of this acreage about 7 million have been reworked.

Control work during 1943 was carried on in cooperation with Federal, State, and private agencies under the over-all leadership and technical direction of the Bureau. The eradication of ribes by all cooperating agencies resulted in the removal of 16,116,886 ribes bushes from 1,141,914 acres of control area, of which 467,270 were initial eradication and 674,644 rework. The details of this work by regions are shown in table 3.

TABLE 3.—*Ribes eradication work of all cooperating Federal, State, and private agencies for the calendar year 1943*

Region	Initial eradication	Reeradication	Total	Effective labor	Ribes bushes destroyed
	Acres	*Acres*	*Acres*	*Man-days*	*Number*
Northeastern	92,928	275,799	368,727	28,287	2,574,503
Southern Appalachian	284,578	278,049	562,627	10,191	817,615
North Central	50,573	58,646	109,219	15,490	2,061,192
Northwestern (Idaho, Montana, and Washington)	8,927	27,820	36,747	47,098	3,790,528
Pacific Coast (California and Oregon)	30,264	34,330	64,594	50,115	6,873,048
Total	467,270	674,644	1,141,914	151,181	16,116,886

SPREAD OF BLISTER RUST

White pine blister rust has been reported from 27 States. In California infection on ribes was found this year for the first time on the Tahoe National Forest, which extends the known distribution of the disease a few miles southward in the commercial sugar pine belt. Rust on ribes also was found in Marin County along the California coast, bringing the disease close to the San Francisco Bay district. Within the sugar pine area of California and Oregon, where rust has been found, a careful search was made for centers of pine infection in all control units. In these centers the cankers on the pines and the ribes in the vicinity were removed. This action temporarily retards the intensification and spread of rust, thus allowing more time for eradicating ribes in additional sugar pine stands in advance of the disease.

In the western white pine type of eastern Washington, northern Idaho, and western Montana the rust is well established and increasing on those portions of the control area where ribes is still prevalent. In 1943 cankers resulting from pine infection in 1941 began to appear. The amount of this infection, particularly in areas where the disease became established in 1937 and on which ribes eradication had not been performed in the meantime, is comparable to the heavy infection wave of 1937. Since 1923, when the rust first reached the western white pine region, more than the average amount of annual pine infection occurred in 1927, 1933, 1937, and 1941.

In the southern Appalachian region there was an increase in the number of infected counties, and continued intensification of the disease in unprotected white pine areas. Blister rust was found for the first time on ribes in Bedford, Botetourt, and Washington Counties in Virginia, and on white pine in Giles, Nelson, and Rockbridge Counties. The rust has now been found on ribes in 29 of the 34 counties in Virginia making up the control area and on pine in 18 counties. Also

the disease was found for the first time on pine in Greenbrier County, W. Va., and was again observed on ribes in Avery County, N. C.

Weather conditions in the North Central States continued to be favorable for the spread of the rust, particularly in the northern part of Michigan, Wisconsin, and Minnesota, where the disease is increasing on pine. In northeastern Minnesota blister rust is developing so rapidly that millions of young white pines will be killed before they can be protected. In some localities the unprotected pines are so severely diseased that they have been abandoned to the rust. One such stand in Sawyer County, Wis., had 70 percent of the trees infected, while another stand in the same county that had been protected by ribes eradication showed less than 5 percent infection.

In the Northeastern States ribes was generally infected, although evidence of pine infection of recent origin is rather meager even in some unprotected areas, which is the reverse of the situation in the North Central States. Some of this is due to weather conditions adverse to rust development, but the chief factor in checking the spread of the disease has been the eradication of ribes on more than 85 percent of the control area.

DEVELOPMENT AND IMPROVEMENT OF CONTROL METHODS

In California dosage tests with aqueous ammonium sulfamate sprays on *Ribes roezlii* Regel confirmed preliminary data showing favorable killing action on this species, which has been markedly resistant to other well-known herbicides. Similar tests with ammonium sulfamate were applied to *R. lacustre* (Pers.) Poir. in northern Idaho, where this species is a troublesome eradication problem on some areas.

Experimental work in extracting ribes seeds from samples of forest duff and soil resulted in the development of a successful method consisting of a combination of mechanical screening and blowing, and subsequent flotation in a saturated solution of calcium chloride. This method will be used in making direct measurements of the potential ribes-regeneration hazard in parts of control areas where these bushes are exceptionally persistent.

Studies were continued on tests of new herbicides for ribes eradication, on sampling methods used to determine pine stocking and disease prevalence, and on the ecology of ribes and white pines. Additional data were obtained on the germination of ribes and white pine seeds; on the effects of logging, burning, and grazing on ribes regeneration; and on the correlation of ribes ecology and pine-management practices.

WHITE-FRINGED BEETLE CONTROL

Inspections for white-fringed beetles were conducted in the Southeastern States and at maritime ports of entry from Brownsville, Tex., to Maryland. Infestations totaling 20,000 acres, including localities at Foley, Ala., and Mendenhall, Waveland, and Collins, Miss., were discovered late in the summer of 1943, and the Federal quarantine was extended to include these areas. An incipient isolated infestation was also found at Vander, N. C. By inspection for larvae in the spring of 1944 infestations were located at Mount Olive and Fayetteville, N. C.

Control operations in all areas reduced beetle populations, lessened damage to vital food, feed, and fiber crops, and minimized possi-

bilities of spread of the pest. Many farmers in infested areas on the Gulf coast adopted recommended planting and cultural practices, including crop rotation, that tend to reduce beetle populations. The planting of small-grain and winter cover crops was increased several fold. Other Department as well as State agencies participated in bringing these practices to the attention of the farmers.

Methods of handling nursery stock were improved, in cooperation with State pest-control agencies. The number of fumigated, barricaded areas and of protected plunging beds has been more than doubled. The percentage of certifiable nursery stock was correspondingly increased. An incipient infestation at Avery Island, La., 125 miles west of any other known infestation, is believed to have been eradicated by methyl bromide fumigation.

Improvement was made in machinery used for applying insecticides. A machine for applying concentrated spray was developed so as to eliminate belt drives, reduce the gross weight, and apply the spray more evenly and uniformly. Field tests have indicated that the concentrated-spray method of applying insecticides is more effective than others against white-fringed beetles.

GRASSHOPPER AND MORMON CRICKET CONTROL

Grasshoppers were somewhat more abundant in the spring of 1944 than in 1943, from Texas north to Montana and North Dakota. Although the infestation was spotted, destructive populations developed locally in 8 to 10 counties in south-central Texas and in western Kansas, central and western Nebraska, and northeastern Colorado, and particularly damaging outbreaks threatened in 10 or 12 counties in central South Dakota. In Wyoming, Montana, and North Dakota the outlook for the 1944 crop season is not particularly alarming, but considerable baiting may be needed in some localities to protect late crops.

Mormon cricket infestations developed in 1944 very much as indicated by the fall egg surveys. Control operations were conducted during May and June in Washington, Oregon, Idaho, Nevada, and Wyoming. More extensive outbreaks occurred in Idaho and Nevada. Wet, cool weather during the spring and early summer retarded both grasshopper and Mormon cricket development and greatly promoted growth of crops and natural vegetation. Early crops that normally would have been susceptible to grasshopper attack had a good growing start, and the natural vegetation provided sufficient attractive cover so that early-season damage was restricted to localized areas.

The grasshopper-control program in 1944 presented several important aspects. Relatively low populations generally offered possibilities for holding infestations at a low ebb with a small amount of timely and effective control work. If a repetition of unfavorable past experiences in the more heavily populated areas was to be avoided, it was necessary to supplement farmer control in such areas with federally-financed spreading of poisoned bait on roadsides and rights-of-way.

To implement this program a new type of blower spreader was designed, and 275 of these spreaders were constructed. This spreader, with a throw of approximately 35 feet to either or both sides, will

give adequate coverage at speeds up to 25 miles per hour. To furnish the amount of bait needed for this purpose, a new type of batch mixer was also designed, which eliminated the need for large mixing-station crews and provided ample quantities of bait at less expense. By July 1 approximately 2,400 tons of bait had been spread by farmers, and 500 tons by States and counties with Federal assistance.

As the result of control operations and natural factors the area infested with the Mormon cricket has been reduced from approximately 19,000,000 acres in 1939 to 940,000 acres in 1944. By July 1 about 550 tons of bait had been spread by plane and 300 tons by power baiting units. A much smaller, though highly important, portion of the area, embracing country inaccessible to mechanical spreaders, was baited by hand. In the combined operation 150,000 acres were covered in 1944, and important savings of range forage and adjacent crops were effected.

CONTROL OF CHINCH BUGS

A moderate infestation of chinch bugs developed in parts of 40 counties across the central part of Illinois. Nearly 800,000 pounds of dinitro-*o*-cresol dust and approximately 250,000 gallons of creosote were supplied to farmers in this State for construction of barriers. More than 100,000 acres of corn were saved. Only limited amounts of barrier were constructed in other States.

BARBERRY ERADICATION

Eradication of rust-spreading barberry bushes in important grain-growing areas is essential to the control of stem rust of wheat, oats, barley, and rye. As a result of organized effort on the part of grain growers, and with the assistance of county, State, and Federal agencies, nearly 70 percent of the approximately 1 million square miles in the 17 States comprising the barberry-eradication area has been protected from local sources of stem rust since control work was undertaken 25 years ago. The remaining 310,500 square miles must be given further attention to eliminate bushes that have grown from seed that were in the ground at the time of the initial survey. Of immediate concern at this time are areas approximating 10,000 square miles last inspected about 6 years ago. Since the new bushes may produce seed when 5 to 6 years old, the proper timing of clean-up work is important if it is to be done most economically and effectively.

ACCOMPLISHMENTS IN 1943

During 1943 difficulties arising from war conditions combined to reduce accomplishments in barberry eradication to somewhat below those of the previous year. Nevertheless, 1,715,933 bushes were destroyed in 252 important grain-producing counties. During the season systematic surveys were applied to 5,456 square miles. Of 11,117 previously infested properties that were reinspected, 4,000 will require no further work. Barberry bushes were located and destroyed on 2,132 properties, 544 representing new locations. The program was confined largely to rework in areas where there was immediate danger of reseeding, and where bushes growing in close proximity to grain fields constituted a serious stem-rust menace.

A summary of the eradication work by States is shown in table 4.

TABLE 4.—*Results of barberry eradication work, calendar year 1943*

State	Area surveyed	Properties cleared		Bushes destroyed		
		New	Old	*Berberis vulgaris*	Native species [1]	Total
	Square miles	*Number*	*Number*	*Number*	*Number*	*Number*
Colorado	124	46	186	11,360	273,110	284,470
Illinois	493	32	53	816		816
Indiana	682	9	36	796	317	1,113
Iowa	592	56	123	2,714	125	2,839
Michigan	906	194	239	5,623		5,623
Minnesota	198	35	97	742		742
Missouri	73	8	26	197		197
Montana	863	2	5	148		148
Nebraska	297	1	8	35		35
North Dakota	641	0	1	27		27
Ohio	177	37	178	6,122		6,122
Pennsylvania	27	25	121	207,656		207,656
South Dakota	113	1	1	5		5
Virginia	18	17	34	16	1,155,875	1,155,891
West Virginia	49	0	141	41	42,444	42,485
Wisconsin	203	81	339	7,764		7,764
Wyoming	0	0	0	0	0	0
Total	5,456	544	1,588	244,062	1,471,871	1,715,933

[1] *B. fendleri* A. Gray and *B. canadensis* Mill.

STEM RUST DAMAGE LIMITED TO LOCAL AREAS

In general wheat west of the Mississippi River escaped serious damage from stem rust in 1943. Barberry bushes rusted later than usual, and less than the normal amount of inoculum of wheat stem rust developed in Mexico and Texas. Only slight damage resulted from the northward spread of the rust. Both in the South and in the western part of the Mississippi Valley there was more stem rust of oats than of wheat.

In the Eastern States the situation was the reverse. There was more abundant development of stem rust of wheat, especially in Virginia, West Virginia, North Carolina, Kentucky, and southern Ohio, while stem rust of oats was light. In Virginia and West Virginia heavy infection also developed early on barberry bushes, and local outbreaks of the disease caused severe damage to wheat in barberry-infested areas.

Stem rust was severe in the vicinity of Palouse, Wash., where losses were estimated to total 150,000 or more bushels of wheat. Observations indicate that it originated on barberry bushes within this area and that very little, if any, was from outside sources.

The rust situation in 1943 in the Virginias and Washington provides additional evidence of the importance of barberry bushes in starting damaging epidemics of stem rust.

DISTRIBUTION OF PHYSIOLOGIC RACES OF STEM RUST

Studies of the distribution of physiologic races indicate that stem rust in the Plains States had a separate origin from the rust in the more eastern States. In the eastern area race 38 predominated on wheat, while west of the Mississippi River race 56 was most prevalent, with race 17 in second place and race 38 rarely found. For the country as a whole only these three races of wheat stem rust were sufficiently prevalent to be of practical importance. The 982 collections of wheat

stem rust yielded 1,455 isolates. Of these, 49 percent were race 56, 24 percent race 38, and 23 percent race 17. Compared with the previous year, there was an increase in prevalence of race 56 and a decrease in races 38 and 17, but no conspicuous change in trends.

Race 8 of the oat stem rust was sufficiently prevalent in 1943 to cause concern regarding its future effect on the performance of Boone and several other resistant varieties of oats, most of which were derived from Victoria × Richland crosses. More than 20 percent of the total isolates of oat stem rust were of races 8 and 10, both of which attack the new varieties. Although there have been indications during the last 5 years that race 8 might become more abundant, the sharp increase in prevalence in 1943 was unexpected since the previous high was about 6 percent in 1940.

The identification of physiologic races of wheat stem rust from 55 viable collections obtained from barberries, grains, and grasses in the Palouse area of Washington and Idaho resulted in 65 isolates comprising 14 races. These were all identified as previously described races, although some of them could have been considered as new ones on the basis of minor but apparently consistent differences. These differences indicate that a great deal of recombination between races had taken place on the barberry bushes. Of these 14 races, the only ones found commonly elsewhere are 56, 17, and 38. These were by far the most prevalent in the Mississippi Valley, but each was isolated only once in the material from the Palouse area. It appears, therefore, that there was relatively little, if any, interchange of rust between this area and other wheat-growing areas in which the prevalence of physiologic races is known.

NURSERY INSPECTION

Applications for permits to ship *Berberis* and *Mahonia* plants under the provisions of Federal Quarantine 38 were received from 42 nurseries during 1943, and 37 were granted. It was necessary to refuse 2 applications because the nurseries were growing susceptible varieties and did not wish to remove them, and the approval of 3 applications was delayed pending the eradication of susceptible plants. Few susceptible barberry plants are now found in nurseries in the States participating in control work, and many nurseries outside the control area are restricting their stock to immune or resistant varieties and species. During the year 17 nursery operators voluntarily destroyed 700 susceptible barberry plants.

INFORMATIONAL ACTIVITIES

Informational activities during 1943 were planned to supplement the survey and eradication program, particularly in territory where work could not be accomplished as scheduled. In Minnesota 55 counties authorized bounties ranging from 2 to 5 dollars for reporting the location of barberry bushes. Numerous news items were written for publication, and 9 papers of a popular or technical nature were issued.

PROGRESS IN SWEETPOTATO WEEVIL CONTROL

The wartime demand for increased food supplies has greatly stimulated sweetpotato production beyond the normal 70 million bushels annually, and has stressed the importance of protecting this valuable

crop against its most destructive insect enemy, the sweetpotato weevil, which thrives in commercial areas of the Gulf Coast States. During 1944, 1,181 farms in Alabama, Georgia, Louisiana, Mississippi, and Texas were cleared of this pest by the cooperation of the Bureau, the States, and the growers. Inspection was then extended into other commercial sections of Louisiana and Texas, where 1,280 additional farms were found infested, and control activities are going forward. The clean-up of fields after harvest and of seedbeds and storage places is effective in combating the weevil.

MOLE CRICKETS CONTROLLED

Populations of mole crickets apparently were reduced in the 15 Florida counties in which a control program was conducted in the summer and fall of 1943. Nearly 33,600 acres of truck-crop plants were spread with sodium fluosilicate bait supplied to 3,096 farmers. By baiting in the seedbeds and planted fields, farmers were able to control the burrowing crickets until the young vegetable plants were well rooted. As has been done in the past, the Bureau supplied the bait, supervision, and technical assistance, and the State plant board transported and distributed the bait to the growers.

SURVEY BEING MADE FOR GOLDEN NEMATODE OF POTATOES

The golden nematode of potatoes, *Heterodera rostochiensis* Wollenweber, was found in a small area on Long Island in 1941. The New York State Department of Agriculture and Markets, in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering of the United States Department of Agriculture, conducted a survey to delimit the infestation, and the former agency established a quarantine on the area, effective March 13, 1944. The source of the infestation is not known. The Bureau of Entomology and Plant Quarantine, in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering and with appropriate State agencies, in June 1944 began a survey of the more important northern potato districts east of the Mississippi River to determine as far as possible their status with respect to this potato root parasite.

PINK BOLLWORM CONTROL AND QUARANTINE ENFORCEMENT

INSPECTION

The pink bollworm situation appeared critical because of an increase in intensity of infestation in Cameron County, Tex., and spread into new areas in Texas and Louisiana. Inspection showed initial infestations in Schleicher, Calhoun, Matagorda, and Brazoria Counties in Texas, and in Cameron, Calcasieu, and Jefferson Davis Parishes in Louisiana. There was also a marked increase in infestation in Hidalgo and Maverick Counties, Tex. In northwestern Texas results were negative in all previously known infested counties except Tom Green. There was an increase in infestation in the Big Bend of Texas over the previous season, although it was substantially lower than during the years of heaviest infestation. The regulated areas of New Mexico and Arizona showed no material changes. Negative findings for a number of years made it possible to release from quarantine four

counties in northwestern Texas and one in eastern New Mexico. The Glendale area in Maricopa County, Ariz., appeared free of infestation, but four specimens, the first since 1939, were taken in the eastern part of the county.

In all regulated areas a total of 60,294 bushels of trash were inspected and 26,986 pink bollworms were found. Outside of regulated areas a total of 31,596 bushels of trash were inspected in Alabama, Florida, Georgia, Louisiana, Mississippi, and Texas. Inspections were negative with the exception of those previously mentioned. Inspection of sea-island cotton fields in north-central Florida was negative. Summaries of the amounts and the results of the various kinds of inspection are given in tables 5 and 6.

TABLE 5.—*Results of inspections for pink bollworm in regulated areas, crop season of 1943*

State	Gin trash		Field			Laboratory	
	Quantity	Pink bollworms	Blooms	Bolls	Pink bollworms	Green bolls [1]	Pink bollworms
	Bushels	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Arizona	31,132	[2] 13	0	18,255	[3] 6	0	0
New Mexico	591	93	0	2,250	0	4,090	0
Texas	28,571	26,880	[4] 1,112,460	12,366	[5] 124	5,592	[6] 111
Total	60,294	26,986	1,112,460	32,871	130	9,682	111

[1] Collected from 1942 cotton crop.
[2] Distributed in counties as follows: Graham 3, Greenlee 4, Maricopa 4, Pinal 2.
[3] From Graham County, although most of the bolls inspected were in Maricopa and Pinal Counties.
[4] Southern Texas.
[5] 112 from blooms and 3 from bolls in Cameron County, 9 from bolls in Hidalgo County.
[6] 100 specimens in El Paso County and 11 in Hudspeth County.

TABLE 6.—*Results of inspections for pink bollworm outside regulated areas, crop season of 1943*

State	Gin Trash		Field				Laboratory [1]	
	Quantity	Pink bollworms	Squares	Blooms	Bolls	Pink bollworms	Green bolls	Pink bollworms
	Bushels	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Alabama	1,370	0	0	0	0	0	0	0
California [2]	0	0	0	0	37,443	0	0	0
Florida	186	0	1,874	574	[3] 48,711	[3] 48	12,010	1
Georgia	2,087	0	0	0	351	0	0	0
Louisiana	4,048	11	0	0	91,127	214	0	0
Mississippi	146	0	0	0	1,748	0	0	0
Texas	23,758	13	0	0	204,031	18	46,594	0
Total	31,595	24	1,874	574	383,411	280	58,604	1
Mexico:								
Chihuahua	1,068	809,304	0	0	0	0	0	0
Coahuila and Durango	780	892,886	0	0	0	0	0	0
Nuevo Leon	523	0	0	0	0	0	0	0
Tamaulipas	565	15,757	0	438,282	0	61	0	0
Total	2,936	1,717,947	0	438,282	0	61	0	0
Grand total	34,531	1,717,971	1,874	438,856	383,411	341	58,604	1

[1] Bolls collected from 1942 crop.
[2] Work done by port and border survey personnel.
[3] 27,385 bolls from sea-island cotton and the remainder from wild cotton. The 48 specimens were from wild cotton.

COOPERATIVE PROGRAM IN MEXICO UNDER WAY

Control operations against the pink bollworm in the United States have been affected by natural spread from heavily infested areas in Mexico. To offset this condition increased funds were provided for the cooperative control work in Mexico, and during the past year Bureau personnel have been working with Mexican agricultural officials, agricultural agencies, and individual farmers to effect improvements in administration of control procedure, particularly in interior areas. Emphasis continues to be placed on efficient regulatory and control practices in border areas, which it is believed compare favorably with those in adjacent areas in the United States.

Farmers in the lower Rio Grande Valley of Mexico destroyed stalks on 125,000 acres promptly after harvest.

PROGRAMS IN THE VARIOUS REGULATED AREAS

For the second consecutive season rains prevented completion of field clean-up in the lower Rio Grande Valley and permitted considerable carry-over of pink bollworms. This resulted in a substantial increase in infestation in 1943. Farmers destroyed stalks on 218,618 acres, and Bureau funds were used to pile and burn stalks in heavily infested fields. The Bureau, in cooperation with Texas authorities, grubbed cotton sprouts from 46,764 acres, in order to establish and maintain a starvation period for the pink bollworm subsequent to destruction of stalks by farmers. To reduce the number of overwintering larvae, the State of Texas has set September 15 as the date for the completion of stalk destruction. This is 15 days earlier than in previous years.

In 1943 no effort was made in the Big Bend of Texas to shorten the growing season through regulation of the planting date, but in 1944 the Texas State Department of Agriculture sought to reduce the number of generations of the bollworm through regulations involving delayed planting.

In Louisiana an intensive clean-up program was carried out with Bureau funds on 2,115 heavily infested acres in Cameron Parish, and the area then was designated as a noncotton zone by State authorities. The State required farmers in two additional parishes to destroy stalks at their own expense.

A total of 876,166 bales of cotton were ginned at 555 gins in the regulated areas of Texas, New Mexico, and Arizona. In all, 352,934 tons of seed were sterilized, 327,980 tons of seed were processed at the 49 designated oil mills, and 484,076 bales of lint and 8,252 bales of linters were compressed at 11 plants. A total of 11,022 bales of Mexican linters were fumigated. The supervision of these treatments required 2,360 inspections of processing plants.

In southern Texas about 2,100 small lots of quarantined products were intercepted through examination of trucks and 24,600 pick sacks that were being carried out of the regulated area by transient workers.

ERADICATION OF WILD COTTON

Eradication of wild cotton from southern Florida was handicapped in some sections because of labor shortages. Infestation continues to be held at a low level in the greatly reduced number of plants, thus

minimizing the likelihood of spread of the pink bollworm to domestic plantings in the Cotton Belt. All west-coast locations and many keys were covered three times. The Cape Sable area, in which many plants occur, and the other keys were covered twice. In all, 29,425 plants with mature bolls and 297,519 current year seedlings, a total of 326,944 plants, were destroyed. This was a reduction of nearly 11.000 in the number of plants maturing bolls, as compared with the 1943 season. Since the inception of wild-cotton eradication in Florida, a total of 16,429,671 plants have been removed.

DOG FLIES CONTROLLED AT ARMY AIR FORCES BASES

To prevent serious interruptions of military training programs along the Gulf coast of northern Florida, the United States Army Air Forces for the third consecutive season provided funds for the control of outbreaks of dog flies (stableflies) in this area in the summer and fall of 1943. By spraying the breeding places of the flies—beach deposits of marine grasses—with 25 percent of creosote in bay water along 562 miles of shore line, the fly populations were greatly reduced and military operations were permitted to function normally. The United States Public Health Service cooperated in the work. A similar program was being conducted in the summer of 1944.

TRANSIT INSPECTION

Because of citrus sterilization requirements in the Rio Grande Valley of Texas during the spring of 1944, additional transit inspectors were assigned at gateways from the valley for several months. Intensive inspection of shipments of restricted fruit leaving the valley resulted in interception of 339 apparently unsterilized shipments. Throughout the year inspection was conducted at 18 transfer points strategically located with respect to movement of restricted articles by common carrier from areas regulated by Federal domestic plant quarantines. There were examined 1,234,471 mail, express, and freight shipments; 2,226 apparent violations of 7 of the 9 Federal domestic plant quarantines and 38 violations of the District of Columbia plant-shipping regulations were reported. Six hundred and eight apparent violations of State quarantines, including those pertaining to phony peach and peach mosaic diseases and the sweetpotato weevil, were reported to State officials.

TERMINAL INSPECTION OF MAIL SHIPMENTS

The States maintaining terminal inspection of mail shipments of plants and plant products under the procedure carried out in cooperation with the Post Office Department, which provides for turning back or disinfecting shipments if found infected, are Arizona, California, Florida, Idaho, Louisiana, Minnesota, Mississippi, Montana, Oklahoma, Oregon, Utah, and Washington. The District of Columbia, Hawaii, and Puerto Rico also maintain this procedure. The States that have availed themselves of the provisions of the terminal-inspection procedure for the enforcement of their plant quarantines are Arizona, Arkansas, California, Florida, Minnesota, Mississippi, Montana, and Oregon.

FOREIGN PLANT QUARANTINES

MARITIME PORT INSPECTION

Many of the effects of war that were noted in previous reports marked foreign-plant-quarantine enforcement in 1944 at maritime ports. Success in the antisubmarine warfare, together with ship construction, resulted in a 39-percent increase in ship arrivals over 1943, and consequently in cargoes subject to inspection; but there was a marked reduction in the need for emergency safeguards for cargoes discharged from ships under distress conditions. Wartime controls over commerce, such as the convoy system, continued to place heavy loads on inspection staffs in peak periods. The use of dry ballast again necessitated large expenditures of inspector-hours in protection against pest risk when the ballast contained top soil.

The record of ship inspections appears in table 7. The data given in this table do not include those for ships engaged only in Great Lakes trade.

TABLE 7.—*Number of ships arriving, inspected, and bearing prohibited plant material, fiscal year 1944*

Origin	Arriving	Inspected	Bearing prohibited material
Foreign ports, direct	21,832	21,749	4,813
Foreign ports, via United States ports	3,442	3,210	191
Foreign ports, via Hawaii	94	94	13
Foreign ports, via Puerto Rico	33	33	12
Hawaii, direct	1,166	1,166	190
Hawaii, via United States continental ports	50	50	----------
Puerto Rico, direct	466	465	38
Puerto Rico, via United States continental ports	30	30	1
United States ports, via Panama Canal	184	184	58
Total	27,297	26,981	5,316

CARGO INSPECTION

Importations of plants and plant products showed an increase for the year, notably in fruits and vegetables, with a falling off in nursery stock. The totals were as follows: Fruits and vegetables, 10,299,785 containers, 30,316,596 bunches of bananas, 17,387,327 pounds, and 86,436 units; nursery stock and seeds, 6,926 containers, 1,661,489 pounds, and 1,700,607 units; cotton lint, bagging, and cotton products, 166,133 bales, 1,155,762 containers, and 37,580,202 pounds; fibers and cereals, 166,089 bushels, 123,462 containers, 6,141,238 pounds, 53,592 dozen, and 17 units. In addition 205 lots of restricted plant material were admitted in accordance with governing regulations at Canadian border ports where no plant-quarantine inspectors are stationed, through the cooperation of the customs officers and the Canadian Department of Agriculture.

Not included in the foregoing totals were several thousand importations of fruits and vegetables over the Mexican border, in such small quantities that no entries are required by customs and no plant-quarantine record of them is made. Each of these small lots was inspected before release, and a large outlay of inspector-hours was required to handle them, especially at the larger ports.

DISINFECTION

The amount and type of plant material treated under supervision of inspectors and collaborators of this Bureau reflect the wartime character of commerce in restricted plant products. The number of bales of cotton, linters, and bagging treated was 195,971, an increase of 12 percent. The total of 30,576,074 pounds of cottonseed cake and meal treated was more than twice the 1943 volume. Weevil-infested vetch contaminating straw jackets around liquor and wine bottles presented a difficult problem in pest protection. Effective steps were taken to bring about the use of unobjectionable packing materials, but 239,148 cases of these products were fumigated in the meantime. Only 39,905 plants, cuttings, bulbs, roots, and other plant-propagating materials were treated; in addition, 19,051 pounds of seeds were safeguarded by treatment. A total of 4,214 samples of cotton lint, linters, etc., and 18,943 containers of other restricted plant products were fumigated or otherwise treated.

AIRPLANE INSPECTION

The rapid expansion of air-borne commerce presented a major plant-quarantine problem during 1944. The inspection of airplanes now arriving in a continuous flow, after only a few hours on the way from many different foreign countries, has become an activity of first importance. As this type of commerce developed, studies were made to appraise the pest risk involved in it and to determine the means available to meet the situation. During the year 21,557 airplanes were inspected at 27 ports of entry, including 2 airports previously without plant-quarantine protection that were temporarily staffed for the last part of the period. There were 8,464 more inspections than in 1943, an increase of 65 percent. Prohibited plant material was found in 3,031 of the airplanes inspected.

In connection with airplane inspection 1,281 interceptions of insects and plant diseases were made. While many of these pests, including mosquitoes, were stowaways that might menace public health, plant pests of economic importance were found in plant material carried in baggage, cargo, mail, and stores. Among the insects found were the Mediterranean fruitfly, the Mexican fruitfly and two other species of *Anastrepha*, one of them probably *serpentina* Wied., the citrus blackfly, and the East Indian bean pod borer (*Maruca testulalis* (Geyer)). Over half of the 44 interceptions of 26 plant-disease organisms were found on orchids, including 1 undescribed rust. The gravity of the pest risk associated with air commerce is emphasized by the speed with which a plant pest can be transported by this means.

FOREIGN PARCEL-POST INSPECTION

The inspection of parcel post from foreign countries developed in 1944 into a plant-quarantine problem of materially increased importance, which will continue until after the return of the armed forces now overseas. The millions of American men and women in uniform who are stationed abroad enjoy customs and postal privileges that place their mail in a class apart from peacetime international mail. Because of its volume and of the customs and postal procedures involved in handling it, this foreign parcel-post traffic creates difficult problems in providing plant-quarantine protection against pest entry. A total of 147,007 foreign parcel-post packages were inspected, an increase of 97 percent over 1943. Of these, 717 were refused entry, in whole or in

part, because they contained prohibited material, 1,664 were diverted to another port for disposition, and 1,361 were released under permit.

MEXICAN BORDER SERVICE

In 1944 a total of 67,755 freight cars from Mexico were inspected, a decrease of 1,429, or 2 percent, from the 1943 total. It was necessary to fumigate 12,985 as a condition of entry into the United States. This represents an increase of 813, or 7 percent, over 1943. Coupons valid for the fumigation of a freight car were sold, at $4 each, in the amount of $52,196. During the year search continued for possible ways to expedite railroad traffic from Mexico by eliminating fumigations when possible to do so without increasing the risk of introducing foreign plant pests. By using certain railroad records, which were carefully compared with other sources of information and confirmed by actual inspections of the cars themselves, it was possible, during the last half of the year, to reduce materially the number of cars requiring fumigation at Nogales, Ariz., without additional risk of pest entry.

In addition, 4,620 Pullman and passenger coaches were inspected upon entry into this country. A total of 4,569,545 other vehicles and 806,809 pieces of baggage were examined in cooperation with customs officials, a decrease of 3.5 percent in the number of other vehicles examined and an increase of 44 percent in baggage examinations.

INSPECTION IN HAWAII AND PUERTO RICO

The predominant activities carried on in the enforcement of Federal plant quarantines governing the movement of plants and plant products from Hawaii to the mainland were preflight inspection of aircraft and the inspection of mail, baggage, and express. The local demand for all fresh fruits and vegetables left little for shipment to the mainland. Inspections and certifications decreased accordingly. Preflight aircraft inspections and the examination of express increased approximately 600 percent over 1943, and necessitated the assignment of additional personnel from the mainland. Mail and baggage inspections continued in volumes approximating 1943 figures; however, conditions surrounding the handling of mail from the armed forces in Hawaii were such that it could not all be made available for inspection prior to dispatch to the mainland. By the close of the year over 60.000 parcel-post packages were being inspected monthly at mainland ports, thus adding materially to the work load of maritime inspectors at Pacific coast ports. The inspectors continued to cooperate with the censors in the examination of mail and express in Hawaii.

In Puerto Rico also the demands for local consumption resulted in very little call for the inspection and certification of fruits and vegetables for shipment to the mainland. Emphasis there is on the inspection of surface vessels and aircraft to prevent both the introduction of foreign plant pests and the spread of injurious pests of Puerto Rico to the mainland. The insular inspectors, acting as collaborators, assist in these activities, all of which have been adjusted to meet the needs of wartime commerce.

DEPARTMENTAL PLANT MATERIAL AND DISTRICT OF COLUMBIA INSPECTION

A total of 411 shipments of incoming domestic material (51,163 plants, cuttings, bulbs, etc., and 2,237 lots of seeds) and 1,793 shipments of outgoing domestic material (200,947 plants, cuttings, bulbs, etc., and 10,730 lots of seeds), including material shipped by the United

States Department of Agriculture, were inspected in the enforcement of the regulations governing the movement of plant material into and out of the District of Columbia. Some form of treatment for the elimination of pests in these shipments was given to 175,517 plants, 1,509 lots of seeds, and 141 parcels containing plant material not for propagation. In addition 25,978 containers were examined at the post offices, express offices, and freight stations, and 19 truckloads containing 68,922 plants consigned to retail merchants in the District of Columbia were checked on arrival for proper certification.

INSPECTION OF PLANT-INTRODUCTION AND PROPAGATING GARDENS

Plant material that is being propagated at plant-introduction and propagating gardens maintained by the Bureau of Plant Industry, Soils, and Agricultural Engineering is inspected regularly for the presence of plant pests. Such material distributed from the gardens at Coconut Grove, Fla., and Mandan, N. Dak., was inspected by State officials cooperating with this Bureau. The inspections at Chico, Calif., were handled jointly by an inspector from this Bureau and an entomologist from the California Department of Agriculture. Material distributed from the District of Columbia, Maryland, and Savannah, Ga., stations was examined by Bureau inspectors. The following were examined prior to distribution from these stations during 1944: 448,178 plants, 1,264 bud sticks and cuttings, 43,388 roots and tubers, and 136 shipments of seeds.

INTERCEPTIONS OF PROHIBITED AND RESTRICTED PLANTS AND PLANT PRODUCTS

The interceptions of prohibited and restricted plants and plant products in 1944 are as follows: In baggage, 46,534; in cargo, 199; in mail, 1,484; in quarters, 6,176; in stores, 3,558; total, 57,951. In addition, interceptions were made in baggage by customs officers at Mexican border ports where no plant-quarantine inspectors are stationed. Customs officers at Canadian border ports without plant-quarantine inspectors made 210 interceptions.

The Bureau is fortunate in having the interested, intelligent cooperation of the customs personnel in the enforcement of foreign plant quarantines, particularly at ports where traffic conditions do not now warrant the services of a plant-quarantine inspector. This is an important factor in maintaining the safeguards against pest entry.

PESTS INTERCEPTED

During the inspection of foreign plants and plant products, and of such products received on the mainland from Hawaii and Puerto Rico, inspectors and collaborators of the Bureau collected insects belonging to 897 recognized species and others distributed among 590 genera and families, as well as fungi, bacteria, nematodes, and viruses belonging to 238 recognized species, and large numbers of other pathogens that could be referred to genus, family, or general group only. Many of these interceptions were of important plant pests; others were of scientific interest, including a number of undescribed species.

The combined total of 43,001 interceptions of insects and diseases made were taken as follows (figures refer to number of interceptions): In material offered for entry for consumption, 23,711 insects, 13,654 diseases; in material offered for entry for propagation, 1,508 insects, 491 diseases; in material not offered for entry, such as in-transit shipments

and materials in ships' stores, quarters, etc., 2,358 insects, 1,279 diseases; total, 27,577 insects, 15,424 diseases. In addition, inspectors stationed in Puerto Rico in connection with the enforcement of the fruit and vegetable quarantine made 60 collections of insects and 8 of diseases during their field and packing-house inspections.

PEST SURVEY IN VICINITY OF PORTS OF ENTRY

During the year 42,879 man-hours were expended in making an insect and plant-disease survey of the more important food crops growing in the environs of the ports of entry and international airports on the Atlantic, Gulf, and Pacific coasts and at the Mexican border, for possible introduced plant pests. A total of 19,698 lots of insect material and 4,450 plant pathological specimens collected in the course of the survey were submitted to specialists for determination.

As a result of the survey samples of several insects and plant diseases known to be of economic importance in foreign areas were collected in the United States for the first time. The most important insects found include two bean pod borers, *Maruca testulalis* (Geyer) and *Fundella cistipennis* Dyar, found in Texas and Florida, respectively; a lepidopterous insect, *Gnorimoschema gudmannella* (Wlsm.), whose larvae attack the flowers and fruits of bell peppers, found in Florida; and the European rose maggot, *Rhagoletis alternata* (Fall.), found in rose hips in the States of Rhode Island and Washington.

Plant diseases found include *Phomopsis tuberivora* Gussow and Foster, which causes a hard stem end rot of potatoes in British Columbia, and *Elsinoe piri* (Wor.) Jenkins, a fungus known to disfigure apple and pear leaves and fruit in Europe, both found in the State of Washington; and the European fungus *Phomopsis juglandina* (Fckl.) Hoehn., found on *Juglans regia* L. in California.

Several insect pests, not widely distributed within the United States, were found in areas where they had not been known previously to occur. New locality records that are of importance include the following: The California red scale, a major pest of citrus, was found in Arizona on lemon and grapefruit trees; two mirids, *Pilophorus perplexus* D. and S. and *Heterotoma meriopterum* (Scop.), known to occur in the Northeastern States, were found in Washington State, the former on plum and the latter on apple and potato; the gelechiid *Gnorimoschema plaesiosema* (Turner), an important pest of potatoes and tomatoes in New Zealand and Australia, and heretofore recorded only in this country from California, where the larvae attack nightshade, was found infesting the same host in Louisiana.

CERTIFICATION FOR EXPORT

A total of 1,716 export certificates covering 594,306 containers were issued to meet the sanitary requirements of foreign countries. Certificates were issued at 29 ports covering 40 commodities which were exported to 58 foreign countries.

INSECT PEST SURVEY AND INFORMATION

Owing to war conditions, no reviewing of literature for survey data was carried on during the year, except what was necessary to meet specific requests for information. Approximately 5,000 current notes were added to the Insect Pest Survey record, increasing the number

of species now on record by about 200. The Survey files now contain records on more than 53,000 species of insects and 5,000 host plants. During the year 125 requests for specific information on survey matters were filled, exclusive of inquiries from the divisions of the Bureau. Four monthly summaries and an annual summary of insect conditions were issued. Ninety-nine press and radio releases were issued.

A total of 404,050 printed publications and 131,390 copies of regulatory material were distributed. The series of circulars on Insects in Relation to National Defense was exhausted and had to be reprinted.

EDITORIAL WORK AND PUBLICATIONS

At the beginning of the year 170 manuscripts were on hand, and during the year 404 were received, making a total of 574. Of these, 32 were withdrawn, 41 were published by the Department, 36 were issued in processed form by the Bureau, and 332 were approved for outside publication. On hand at the end of the year were 134 manuscripts, 111 of which were in the Bureau, 15 in the Office of Information, and 8 in the Government Printing Office. Of the 111 in the Bureau, 44 were being reviewed or edited for departmental publication and 67 for publication outside.

The Bureau's 41 Department publications included, in addition to the annual report of the Chief of the Bureau, 6 Circulars, 4 Farmers' Bulletins, 4 Leaflets, 3 Miscellaneous Publications, 5 Service and Regulatory Announcements, 11 Technical Bulletins, and 7 articles for the Journal of Agricultural Research.

ORGANIZATION OF THE BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Chief of Bureau	P. N. Annand.
Associate Chief	A. S. Hoyt.
Assistant Chief (regulatory)	S. A. Rohwer.
Assistant Chief (research)	F. C. Bishopp.
Assistant Chief (control)	W. L. Popham.
Assistant Chief (administration)	F. H. Spencer.
Division of Finance and Business Services	B. Connor.
Division of Personnel	William F. Leffler.
Editorial Office	Rolla P. Currie.
Division of Insect Pest Survey and Information	G. J. Haeussler.
Division of Fruit Insect Investigations	D. L. Van Dine.
Division of Fruitfly Investigations	A. C. Baker.
Division of Mexican Fruitfly Control	P. A. Hoidale.
Division of Japanese Beetle Control	E. G. Brewer.
Division of Forest Insect Investigations	F. C. Craighead.
Division of Gypsy and Brown-tail Moth Control	R. A. Sheals.
Division of Plant Disease Control	J. F. Martin.
Division of Cereal and Forage Insect Investigations	C. M. Packard.
Division of Truck Crop and Garden Insect Investigations	W. H. White.
Division of Cotton Insect Investigations	R. W. Harned.
Division of Pink Bollworm and Thurberia Weevil Control	L. F. Curl.
Division of Bee Culture	J. I. Hambleton.
Division of Insects Affecting Man and Animals	W. E. Dove.
Division of Insect Identification	C. F. W. Muesebeck.
Division of Foreign Parasite Introduction	C. P. Clausen.
Division of Control Investigations	C. P. Clausen.
Division of Insecticide Investigations	R. C. Roark.
Division of Foreign Plant Quarantines	E. R. Sasscer.
Division of Domestic Plant Quarantines	B. M. Gaddis.
Division of Grasshopper Control	Claude Wakeland.

U. S. GOVERNMENT PRINTING OFFICE: 1945